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# HAWAIIAN MONK SEAL WORK PLAN FISCAL YEARS 1994-96

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ADMINISTRATIVE REPORT H-93-16

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Southwest Fisheries Science Center
Administrative Report H-93-16

# HAWAIIAN MONK SEAL WORK PLAN

## Fiscal Years 1994-96

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## INTRODUCTION

This plan was developed to guide Hawaiian monk seal (*Monachus schauinslandi*) research and recovery activities conducted by the Marine Mammal Research Program (MMRP) and the Protected Species Investigation, Honolulu Laboratory, Southwest Fisheries Science Center, National Marine Fisheries Service (NMFS), NOAA. In developing this task outline, consideration was given to the priority assigned to specific research and recovery tasks in the *Recovery Plan for the Hawaiian Monk Seal, Monachus schauinslandi* (Gilmartin 1983), the recommendations of the Hawaiian Monk Seal Recovery Team at its January 1992 and January 1993 meetings (Appendix A and B, respectively), and the recommendations of the Marine Mammal Commission following its review of monk seal research and recovery activities in November 1991 (Appendix C).

The 1991-93 Work Plan (Gilmartin 1990) outlined the following four major work areas:

(1) recovery of the western populations (Kure Atoll, Midway Islands, and Pearl and Hermes Reef);

(2) mobbing research;

(3) monitoring of the five major breeding populations; and

(4) data analysis and preparation of reports and publications.

Significant accomplishments and events relating to these 1991-93 efforts have been:

- conclusion of the highly successful Head Start Project at Kure Atoll in 1991;

- decommissioning of the U.S. Coast Guard loran station at Kure Atoll in 1992;

- closure of the Midway Air Facility in 1993;

- reintroduction of rehabilitated females to Midway Islands in 1992, but no further releases at this site because of observed high mortality;

- mobbing research preliminary to a large-scale research project at Laysan Island completed in 1992 but insufficient funds in 1993 to complete experimental work;

- population monitoring of the breeding islands in 1990-93 showed a sharp decline in births at all sites in 1990, followed by recovery in 1991 except at French Frigate Shoals (FFS);

- the FFS population has experienced low birth rates and low immature survival rates since 1990 causing a decline in that population of more than 25%;

- collecting underweight female weaned pups at FFS for rehabilitation continues, reintroductions are being made at Kure Atoll;

- A 1992 FFS juvenile rehabilitation effort suggested these older seals benefitted less from this care than pups and yearlings;

- a workshop on ecosystem changes in the Hawaiian Islands was held to help explain the seal population decline at FFS;

- studies of monk seal prey preferences and abundance of reef prey populations were initiated at FFS;

- the Pearl and Hermes Reef seal population is growing at an annual rate of at least 5%;

- monk seal population status report (Ragen 1993) completed;

- the journal publication rate was increased during 1991-93 (see Appendix D); and,

- MMRP staff cooperated with the IUCN Seal Specialist Group, the French Ministry of the Environment and scientists of the Parc National de Port Cros in developing a detailed protocol for a captive breeding program for the Mediterranean monk seal.

Much of the work presented in this 1994-96 plan is a continuation of MMRP activities which have been assigned high priority by the Recovery Team. MMRP staff complete a summary of all field data following each summer's field season. These data are reviewed, giving consideration to any adjustments that may be necessary in planning the activities for the following season. Annual meetings of the Hawaiian Monk Seal Recovery Team in recent years have enabled the Team to also review current research findings and make or modify recommendations for future efforts. Therefore, some aspects of the research outlined in this plan may change slightly; however, the general priorities within this 1994-96 schedule are not expected to change significantly as a result of these program reviews.

The recovery plan (Gilmartin 1983) does not include a recovery goal for the Hawaiian monk seal population and the Recovery Team has postponed discussion of this topic. However, based on current population status and trends (Ragen 1993), none of the island populations west of French Frigate Shoals are expected to approach the population numbers of the 1950s (which are likely to be minimal population goals) within the time frame of this work plan. Consequently, recovery goals which may be generated will not likely affect the overall priority of the research identified in this plan.

This 1994-96 work plan addresses five major concerns of the MMRP and the recovery team:

(1) monitoring of the five major breeding populations and Midway;

(2) resolution of the mobbing problem at Laysan and Lisianski Islands;

(3) implementation of the research and management plan for the FFS population (Gilmartin 1993);

(4) continuing activities to enhance recovery of the western island populations; and,

(5) continuing emphasis on data analysis and publication of research findings.

Hawaiian monk seal field research methods include precautions to minimize disturbance of the seals. While conducting beach censuses and tag resighting patrols, observers attempt to stay out of sight of the seals. Any response of the seals to the observers is noted and shows that approximately 3% are inadvertently disturbed during censuses. The most important management tool for indicating problems and assessing the consequences of recovery actions is the pup tagging and tag resighting effort. The results of a study of the possible effects of flipper-tagging pups (Henderson and Johanos 1988) and observed 100% survival for some island/pup cohorts suggest these procedures are not detrimental to the population. Details of the methods and some recent results of this research can be found in the reports and publications of the MMRP program (Appendix D); only general descriptions of the various proposed tasks are provided in this plan. Recovery team members and MMRP staff have contributed to this plan.

## Research Task Descriptions

The tasks described below are scheduled in the work plan outline (Table 1). The numbers in parentheses following the title of each task below indicate the *Recovery Plan* (Gilmartin

1983) items which the task addresses. Actions that are not a number one priority may be included in these lists, but they are performed as time allows, usually as part of a larger and higher priority field effort and usually with little or no additional cost.

**A. Island-Specific Population Monitoring (*Recovery Plan* actions addressed: 1.11, 1.12, 1.21, 1.22, 1.23, 2.11, 2.15, 2.21, 2.32, 2.35, 3.11, 3.13, 3.14, 3.15, 3.2, 4.1, 4.3, 4.4, 5.18, 5.29)**

This task requires 6-14 weeks of field time between mid-April and mid-August at each of the five major breeding sites (Kure Atoll, Pearl and Hermes Reef, Lisianski and Laysan Islands, and FFS) and Midway. This field time is sufficient to perform at least 10 complete beach censuses at all seal hauling sites at these locations and flipper-tag 75-100% of the pups. The field time and cost required varies widely by site because access to all the hauling sites depends largely on weather and sea conditions at the multi-island atolls.

Pup tagging enables permanent identification of individual animals. With a comprehensive tag resighting effort, data are collected that are critical to monitoring age-, sex-, and island-specific patterns of survival, movement, reproduction, haul out, and behavior. Combined with bleach-marking of seals, these data enable precise estimation of the size and sex composition of the population at a particular location. Immature seals which are found untagged are also tagged to enable long-term identification.

Incidental to the above activities, this task accomplishes several other important functions: Deaths are documented and identified to probable cause, and necropsies are performed to develop further information on causes of mortality; injuries are documented and identified to probable cause, and healing is monitored; beach debris capable of entangling seals is collected, cataloged, and destroyed; seals found entangled are released; small tissue plugs from flipper-tagging are collected for DNA fingerprinting; and scat and spew samples are collected for prey species determination.

In the event that MMRP resources are insufficient for a population monitoring effort at any of the major breeding islands during a season, an attempt will be made to conduct at least one pup tagging visit to the site. During these visits, two or more persons will patrol the island beaches for 1-3 days and tag and measure all weaned pups encountered. This tagging method is much less thorough than the long-term camps because the prolonged pupping season and changes in hauling patterns during the first 3-5 months of life dictate that a high proportion of pups will be missed in a short visit, regardless of time of year. Additionally, pup measurements are of little value when weaning

dates are unknown. Nevertheless, these visits, in the absence of a full population monitoring effort, will enable some fraction of the pup cohort at a specific site to be tagged, which will subsequently augment survival, movement, and reproductive data. Additionally, the short visit allows a brief inspection of the population to check for possible die-offs or other unusual events that may be evident.

**B. Mobbing Problem Research (*Recovery Plan* actions addressed: 1.22, 1.4, 1.5, 3.12, 3.13, 3.14, 3.21, 3.223, 3.225, 3.24, 4.1, 5.29)**

This task has been guided generally by *A Plan to Address the Hawaiian Monk Seal Adult Male Mobbing Problem* (Gilmartin and Alcorn 1987) and the adult male treatment/removal plan recommended by the Recovery Team at its January 1992 meeting (Appendix A). These plans suggest a combination of "chemical" and physical removal of males from the monk seal population at Laysan Island, which has been the study site for this problem. Treatment of males with a GNRH-agonist drug which suppresses testosterone and aggressive behavior associated with breeding (Yochem et al. submitted, Blumer et al. 1992) can be used as a temporary means of eliminating the mobbing behavior of individual males. Physical removal of mobbing males permanently ends their participation in attacks on females. The research to determine which males should be removed is a continuing project and requires collecting behavioral data, monitoring adult male aggression and female mortality, and maintaining identification of all seals at Laysan Island.

The MMRP schedule during 1994-96 includes physical removal of up to 30 adult males from Laysan Island. The goal is to remove males which are known to participate in mobbing events and those whose behavior profile suggests they have a high probability of taking part in these attacks. The latter approach is necessary because of the infrequent number of attacks observed. The MMRP has organized a meeting in October 1993 that includes other phocid and exotic wildlife reproductive biologists and veterinarians and the recovery team behaviorist and will review and modify as appropriate the MMRP draft selection criteria for males to be removed. This effort will result in a priority assignment of individuals for collection and treatment. Identified dominant breeding males (based on observed behavior or DNA fingerprinting techniques) will not be collected or treated.

The MMRP hopes to identify suitable captive facilities which will take the collected seals into permanent care or find a suitable site in the wild for relocation. GNRH-agonist treatments will be used in the wild as an interim measure to control the most dangerous males until they can be permanently removed. Following the adult male removals during 1994-96, the Laysan Island population will be monitored for the next 2 years for evidence of immature and adult female injuries and deaths due

to mobbing attacks. Following that observation period, a decision on the need for further action will be made.

Permanent marking of adult seals is essential to maintain identification in the mobbing research and is called for in Gilmartin and Alcorn (1987). Adult survival data is also critical to development of models for use in evaluating the effects of various population management actions. Passive integrated transponder (PIT) tags will be evaluated for application to adult seals by use of a jab stick. These tags are currently being applied to weaned pups and immature seals at the time of flipper-tagging. While flipper tags are entirely adequate in immature seals, tag readability and retention appear to decrease significantly after 5 years. A PIT tag should allow reidentification of a seal at any time and potentially can be applied by one person without restraint of the seal. Seals in the population not yet PIT tagged should be tagged as soon as this tagging technique is fully tested.

**C. French Frigate Shoals Research and Management Plan Implementation (*Recovery Plan* actions addressed: 1.1, 1.3, 1.4, 2.13, 2.2, 2.3, 3.14, 3.22, 3.23, 3.24, 5.18, 5.29)**

The monk seal population at FFS has experienced dramatic losses beginning in 1990 due to reductions in birth rates and immature survival (Gilmartin 1993). These changes may be related to decadal scale oceanographic conditions which appear to have reduced productivity in a larger area but have most dramatically affected monk seals at FFS (DeMartini et al. 1993, Polovina et al. in press). A population research and management activity outline specifically addressing the situation at FFS was developed by the MMRP in consultation with the Recovery Team at its January 1993 meeting. The FFS research and management plan (Gilmartin 1983), developed following this meeting, will guide activities at FFS during the period of this 1994-96 work plan.

The FFS research and management plan addresses these major activities: monitoring the population size and composition; monitoring growth rates of young seals and diseases in the population; rehabilitation and relocation of young seals; research into prey species and foraging and hauling patterns; assessment of seal interatoll movement patterns, tag loss rate, investigation of permanent marking methods; and placing added emphasis on data analysis and summary reports for this site. Funding for this work is included in both the population monitoring and FFS research and management plan tasks in Table 1.

While most of these projects will be conducted at about the same level each year, the large differences in implementation costs under the FFS research and management plan category in Table 1 reflect the changing effort in the foraging pattern research during this time. Pilot studies and proposal development will be completed in FY 1994, followed by (with

sufficient funding) an expanded population assessment of foraging patterns in FY 1995, and data analysis and report preparation in FY 1996.

**D. Recovery of Western Populations: Kure Atoll, Midway Islands, Pearl and Hermes Reef (*Recovery Plan* actions addressed: 1.11, 1.12, 1.14, 1.4, 2.11, 2.15, 2.21, 2.35, 3.13, 3.14, 3.2, 4.2, 5.26)**

The rehabilitated pup/yearling reintroduction project has experienced high survivorship of animals released at Kure Atoll in 1985-91. The source of animals has been FFS where small (<95 cm axillary girth) female pups and yearling seals with a low chance of survival are collected. The seals are transported to Honolulu for care and rehabilitation. Following successful rehabilitation (4-12 months), release candidates are screened for diseases before transport to the release site and reintroduction. Although the western population clearly benefits from this project, the major cost of the effort (collection/transport/ rehabilitation) is included in funds indicated for implementation of the FFS research/management plan in Table 1.

In 1992, low survival rates in immature seals at FFS triggered collection of 1-3-yr-old seals and included several different rehabilitation/release schemes. Twenty rehabilitated seals were taken to Midway Atoll that year. An evaluation project in 1993 suggests that mortality of these animals was high (only 2 were resighted). The cause of this high loss is unknown. Additionally, naval air facility operations at Midway are now scheduled to end in late 1993. The station closure, however, will result in the beginning of a massive 5-10 year toxics clean-up effort that will include some beach activities. Considering these factors, the MMRP decided to halt monk seal introductions at Midway and investigate, as may be practical, the potential causes of the high seal losses in animals introduced in 1992.

In 1993, rehabilitated seals were again introduced at Kure Atoll and preliminary observations suggest that survival there continues to be high.

Monitoring these three western populations for the data necessary to estimate population trends and assess the survival of introduced females is a critical part of the recovery effort. The cost of this work, including the costs associated with transport and release of the rehabilitated seals, is included in the Population Monitoring task of Table 1.

**E. Data Analysis/Field Reports/Publications (*Recovery Plan* actions addressed: 1-4, 5.22, 5.23, 5.24, 5.26, 5.29)**

The NOAA Technical Memorandum will continue to be the vehicle for publication of the annual compilation of population monitoring data. Scientific journals will continue to be the

vehicle for publication of highlights of the research findings and results of recovery activities. A complete list of these reports and publications to date is included in Appendix D.

A Hawaiian monk seal population model has just been developed for Laysan Island to assess the effects of management actions at that site to resolve the adult male mobbing problem. This model will be further used to project future trends in other populations that may be difficult to predict because of lag times due to age structure effects. This application will be most important at FFS, the population currently experiencing significant declines in births and juvenile survival.

## RESEARCH AND RECOVERY ACTIVITY SCHEDULE AND TASK PRIORITY

The three-year (1994-96) schedule of Hawaiian monk seal research and management tasks is presented in Table 1. The priorities assigned to these tasks by the MMRP, using the *Endangered and Threatened Species; Listing and Recovery Priority Guidelines* (U.S. National Marine Fisheries Service, 1990) are all 1. At its December 1989 meeting, the Hawaiian Monk Seal Recovery Team also gave all of this listed work a priority of 1 (Appendix A). Although not specifically addressed, the recommendations of the U.S. Marine Mammal Commission following its December 1989 review of MMRP monk seal research and recovery work reflect the same priority status for these tasks (Appendix C).

Field research and recovery actions are indicated for each of the five major breeding islands and Midway Islands in Table 1. The table also provides the site-specific costs associated with performing the tasks. The costs listed in Table 1 for Tasks A and C include the funding required Task D; recovery of the western populations and Task E funds are included with each of the other tasks (A-D) by site. For the same work, an estimated inflation rate of 5% per year is incorporated into FY 1995 and 1996 figures. Costs for a specific field task vary by location because of local logistics of managing the work (e.g., small boat support and additional staff required at some sites), the number of seals at the location and whether other support (e.g., U.S. Coast Guard, U.S. Fish and Wildlife Service, U.S. Navy) is available.

The funding figures assume that the NOAA ship *Townsend Cromwell* is available at no cost to MMRP to provide logistical support for the field camps within the timeframes required. Should ship or additional aircraft charters become necessary, additional funds will be required to complete the activities scheduled, or the charter funds will have to be taken from planned research tasks, thus reducing the level of field research or laboratory support effort within that year.

It is important to note that continuing to monitor these small populations is essential to the overall recovery effort. Only in this way can problems within the populations be detected and the effects of experimental recovery actions be assessed. In addition, the population status, trends, and problems among the five major breeding locations are different, and therefore each must be carefully tracked to learn as much as possible about the dynamics of monk seal populations and what responses may be expected from future recovery actions and management strategies. Additionally, these population data collected within the scheduled tasks of the work plan should contribute to development of realistic population recovery goals.

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Table 1.--Outline of the Hawaiian monk seal work plan and its associated costs, 1994-96.

| Task | Recovery priority | Fiscal year | Field Site[a] | | | | | | | Total funds[b] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | N/N | FFS | LAY | LIS | P&H | MID | KUR | MGMT | 1994 | 1995 | 1996 |
| Population monitoring | 1 | 1994 | | 110 | 85 | 59[c] | 79 | 32 | 63 | 81 | 509 | | |
| | | 1995 | 39 | 115 | 89 | 62[c] | 83 | 34 | 66 | 85 | | 573 | |
| | | 1996 | | 121 | 94 | 65[c] | 87 | 35 | 69 | 89 | | | 560 |
| Mobbing research | 1 | 1994 | | | | 128[d]/203[e] | | | | 35 | 163/238 | | |
| | | 1995 | | | | 79[d] | | | | 25 | | 104 | |
| | | 1996 | | | | 75[d] | | | | 30 | | | 105 |
| FFS research/ management | 1 | 1994 | | 157 | | | | | | 15 | 172 | | |
| | | 1995 | | 276[f] | | | | | | 25 | | 301 | |
| | | 1996 | | 109 | | | | | | 17 | | | 126 |
| TOTAL | | | | | | | | | | | 844/919 | 978 | 791 |

[a]Legend: N/N = Necker and Nihoa Islands; FFS = French Frigate Shoals; LAY = Laysan Island; LIS = Lisianski Island; P&H = Pearl and Hermes Reef; MID = Midway Islands; KUR = Kure Atoll.

[b]Funds include data base maintenance and publication of annual field report.

[c]Includes monitoring mobbing activity.

[d]This is the cost of removing up to 30 adult males over 3 years; year one includes costs of appropriate collection and transport equipment and building temporary holding facilities.

[e]Includes male removal *and* treatment of up to 50 adult males with testosterone-suppressing drug.

[f]Population foraging pattern study.

# APPENDIX A

**UNITED STATES DEPARTMENT OF COMMERCE**
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July 29, 1992 F/SW033:ETN

MEMORANDUM FOR: F/SW - E. C. Fullerton

FROM: for Robert Brownell - Hawaiian Monk Seal Recovery Team Leader

SUBJECT: Recovery Team Meeting, January 15-17, 1992

The following summarizes the results of the third meeting of this Hawaiian Monk Seal Recovery Team. Present at the meeting were Brownell, DeLong, DeMaster (absent 1/17), Eberhardt, Gilmartin, Johnson, Kawamoto, Nitta, and Stirling. Staff from the Honolulu Laboratory's Protected Species Investigation, Marine Mammal Research Program (MMRP) were also present and provided background information and status reports on the various field activities. Bill Perrin represented the Marine Mammal Commission as an observer.

Introductory comments were provided by Brownell and Gilmartin and the Team was welcomed by Laboratory Director George Boehlert. The 1992 budget for the Laboratory's Hawaiian monk seal research program was reviewed by Gilmartin. Out of a $550K congressional add-on the Laboratory is supposed to receive $445K after 8% and 12% assessments by headquarters and the Southwest Center respectively. This is in addition to the $255K base for the program proposed by the Laboratory for a total of $700K for FY92.

Ebernardt then presented a review of population trends with the primary empnasis on looking at site specific issues. This is particularly important because the monk seal populations on French Frigate Shoals, Midway, Kure, Pearl and Hermes Reef, and Laysan and Lisianski Islands are all behaving differently. These differences are likely due to the degree to which the sex ratio and age structure are imbalanced, differences in population size, differences in status relative to carrying capacity, whether "headstart-type" programs are operative, the degree to which fishery interactions have occurred, and the recent history of stochastic events (e.g., disease episodes).

A general population overview and island by island review was presented by MMRP staff. The two primary indices used to monitor the health and status of the population are mean beach counts and number of births. Total births declined significantly in 1990, and showed little recovery in 1991. The total beach counts for the major populations show a decline from 1986 through 1991.

Population Monitoring

Partly in response to the Marine Mammal Commission's (MMC) opinion (letter to Dr. Fox 12/20/91) that MMRP resources might be better utilized by emphasizing "species restoration tasks" rather than population monitoring activities, and to evaluate the need for monitoring, the Recovery Team discussed this issue in some detail. The Team believes that without annual surveys at every island and atoll it would not be possible to understand the factors responsible for future declines or evaluate the effectiveness of "restoration tasks". Each island/atoll sub-population appears to be behaving differently and it is not possible to generalize from one location to another. Survival is the most important parameter and cannot be estimated without annual surveys. Other data including annual pup production, effects of ciguatera outbreaks, and impacts of fishery interactions, can be collected during these surveys as well. Short term events that could have significant population impacts would not be identified without an annual effort as evidenced by the drop in pup production and declining beach counts at French Frigate Shoals over the past two years. **The Recovery Team suggested MMRP determine whether and how data collection, summarization, and reporting could be made more efficient.**

The Recovery Team discussed the advantages (and disadvantages) in continuing the existing monitoring program, where field camps are stationed on most or all of the islands, versus alternative and supplemental censusing regimes, where field camps would be stationed in alternate years or every third year on individual islands in combination with the use of remote sensing techniques to monitor annual production. It was noted that several activities that directly contribute to the recovery of this species are only possible when field camps are stationed on individual islands (e.g., disentangling animals caught in derelict fishing gear or other debris; removal of overly aggressive males; quick response to acute, catastrophic events such as a die-off caused by ciguatera poisoning; etc.). Finally, the Team concurred that while activities that directly promote the recovery of this species, such as "headstarting" female pups at Kure, are a higher priority than monitoring, the number of such activities is limited, and, where data exist to indicate a positive response, such activities have already been undertaken. Therefore, any cost savings realized by reducing the number of field camps in a given year would not be directly used to enhance the recovery of this species, but would rather be used to conduct research needed to evaluate the potential of various other measures for promoting the recovery of monk seals. **Because the monitoring program incorporates several enhancement activities and provides critical interpretive data and because funding the monitoring program does not seem to be precluding the initiation of any additional restoration tasks, the Recovery Team recommended that the annual monitoring program should be continued for all major pupping areas.**

In recommending the continuation of the island-specific monitoring program, the Recovery Team recognized that in the course of tagging and censusing seals, information was being collected that could be used: (1) to determine what, if any, additional management actions should be taken at a site, and (2) to evaluate the response of specific populations and the species to on-going management activities (see Fig. 1). The Recovery Team believes that without annual island-specific monitoring the Service's ability to understand changes in the abundance or composition of the monk seal population will be compromised. For example, the alternate year monitoring at Lisianski and Pearl and Hermes Reef, which was necessary because of funding constraints, has made it very difficult to compare the response of monk seals to an apparent environmental perturbation in 1990 at these islands to other islands. An additional example was discussed concerning the critical importance of monitoring annual survival rates of seals in predicting future trends in abundance. The Team is not aware of any other method of gathering the data needed to estimate annual survivorship other than by ground surveys.

**There was agreement among Recovery Team members that, if the variability in the birth, death, and migration rate of monk seals was negligible among islands or between years, monitoring efforts could be reduced. However, all members of the Recovery Team concurred that inter-island and -year variability in vital rates was high.**

Habitat Use and Studies

Discussion concerning this issue included the Commission's concerns over the at-sea distribution of Hawaiian monk seals between 50 and 200 nautical miles from the Northwestern Hawaiian Islands (NWHI). The Team discussed and commented on planned MMRP studies to elucidate foraging habitat, at-sea distribution, prey species, and reef productivity. Habitat research activities planned by the Honolulu Laboratory for FY 92 include the following:

1. Placement of VHF radio transmitters and time-depth recorders on selected adult male seals.

2. A pilot study on the feasibility of satellite tag use.

3. Scat and spew collections by age/sex class at all five sites.

4. Contract literature search on prey abundance, distribution, and productivity.

5. Prepare summary of current knowledge of monk seal prey species.

6. Contract literature review on possible condition and productivity indices of the NWHI.

Prey Studies

The primary assessment methods identified by the MMRP include collection of scats and spews, and stomach contents from dead animals. It was noted that bias and variation is inherent in the data collected from spews and scats; thus, even the relative significance of certain prey items needs to be interpreted cautiously. It was further noted that in the NWHI, local reef productivity is likely very important.

Headstart and Pup Rehabilitation

The Recovery Team was advised that the headstart program at Kure will be terminated in 1992, but monitoring, including tagging and monitoring survival of weaned female pups, will continue. Gilmartin proposed that rehabilitated female yearlings from French Frigate Shoals be placed at Midway and acclimated in an enclosure similar to the one used at Kure. All animals to be introduced to Midway will be screened for diseases prior to placement. Ciguatera testing of selected fish will be completed prior to introducing seals to Midway. **The Team concurred with the proposal to discontinue the headstart program at Kure and to initiate the translocation of animals from French Frigate Shoals to Midway, following screening procedures, and recommended permanently tagging all animals at Midway, including adult females.**

**With regard to the closure of the Kure Loran Station, the Recovery Team recommended that the U.S. Coast Guard clean up the dump site before demolishing the antenna, buildings, and fuel tanks, and remove all hazardous debris. The Team also recommended that NMFS monitor the station closure and clean-up to ensure that seals are not disturbed.**

Mobbing

MMRP staff provided background on the mobbing issue so that the Team could discuss management/research options and plans. It was determined that whatever action was implemented to address the mobbing problem at Laysan the ability to statistically detect a clear effect would be difficult. This is because of the variability of the seal counts at Laysan and the long time period probably needed (8-10 years) to detect a significant change. **Regardless, the Team recommended that attempts should be made to mitigate the mobbing problem because of the expected improvement in survival of adult females.**

Gilmartin presented a proposal for 1992 to test the effects of drug treatment to eliminate or reduce the number of deaths related to mobbing incidents on Laysan Island. Adult male seals identified as "mobbers" in the behavioral profile data base from Laysan Island would be the targets for testosterone-suppressing drug treatments to reduce mobbing. Thirty seals would be used in the drug test: 10 would be in the treatment group, 10 in the control group for handling (i.e., the animals would be injected with a placebo), and 10 in the non-handled control group. Ten adult male monk seals would also be removed permanently from Laysan. No more than five of the "removed" animals would be from the treated group of animals. The remainder (up to a total of 10) would be other adult males ranking high on the mobber profile list. Although one Team member disagreed with the physical removal of mobbers, he acknowledged that some action to address the situation was imperative. The proposed treatment/removal plan was discussed and modified extensively at the meeting. The following is the Team's unanimous recommended action plan to follow the 1992 treatment of 10 adult males at Laysan.

ADULT MALE TREATMENT/REMOVAL PLAN

| 92 ♀♀ Deaths | 1993 Action | 93 ♀♀ Deaths | 94 Action |
|---|---|---|---|
| 0 - 1 | Treat 10 ♂♂ | 0 - 1 | Remove 10 ♂♂ |
| | | 2 - 7 | Remove ≤ 50 ♂♂[1] |
| | | 8+ | Reconsider action |
| 2 - 7 | Treat 50% ♂♂ | 0 - 1 | Remove 50 ♂♂ |
| | | 2 - 7 | Remove ≤ 50 ♂♂[1] |
| | | 8+ | Reconsider action |
| 8+ | Reconsider action | | |

[1] Permanently remove or permanently drug ♂♂.

Captive Experiments

The Recovery Team was informed by the MMRP that mobbing-related research on captive animals for 1992 would include:

1. Introduction of a captive female to drug-treated and untreated males and monitor for dominance among the males.

2. Treatment of dominant male(s) with the testosterone agonist and observations of subsequent behavior.

3. Test different combinations of males and females and adjust treatment timing relative to ovulation of the female.

Tern Island, French Frigate Shoals

Gilmartin presented a summary of the underground fuel tank rehabilitation project that was completed by the Corps of Engineers this past summer on Tern Island. No significant adverse affects on seals or turtles were observed by Gilmartin during his stay on Tern Island to monitor the project.

Margo Stahl from the Corps of Engineers described the current status of the seawall rehabilitation project at Tern Island. With no remedial action the existing seawall will continue to deteriorate and eventually result in the runway becoming unusable. Without the runway continued operation of the U.S. Fish and Wildlife Service field station will not likely be possible. A number of alternatives were under consideration. These include: 1) replacing or augmenting the existing sheet pile with new sheet pile, 2) replacing the existing sheet pile with concrete tribar revetments, and 3) replacing the existing sheet pile with rock revetments. Discussions are continuing between the U.S. Fish and Wildlife Service and NMFS to evaluate the alternatives and prepare a draft engineering plan and environmental assessment. These reports are scheduled for completion by May 1992.

Fisheries Interactions

The Recovery Team recommended the following activities be conducted, if possible:

1. As resources allow, the Southwest Region should look into placing observer(s) on lobster boats fishing in the NWHI on a voluntary basis to obtain monk seal interaction and distribution data.

2. The Southwest Region should obtain the most recent summaries of lobster, longline, and bottomfish fisheries in the NWHI in order to determine if there is a problem with monk seal interactions or resource allocations.

3. If broadbill swordfish move into the protected species zone, the NMFS should request Coast Guard overflights to monitor potential poaching activity.

4. The Southwest Region should review existing bottomfish observer reports to identify any unaddressed issues - handling of by-catch, incidental feeding of monk seals and dolphins.

Other Studies

Tagging of Adult Females - Sixteen adult females were flipper-tagged in the fall of 1990 to determine what effect, if any, tagging might have on these animals. A range of reproductive and behavior parameters were monitored, including subsequent birth rate, date of birth, pup survival to weaning, pup weight at weaning, length of nursing period, and hauling frequency and location. Preliminary analysis suggests there were no large-scale negative effects. However, the analysis was compromised because the probability of detecting significant change (statistical power) was low.

Tim Ragen noted that, in general, studies of the Hawaiian monk seal will suffer from the combination of small sample size and large variability in life history parameters. In addition, the lack of statistical power in these studies may reflect inappropriate reliance on hypothesis testing with a traditionally low level of acceptable Type I error (i.e., $\alpha$=0.05). He suggested that greater emphasis should be placed on the careful consideration of acceptable levels of Type I and Type II errors prior to data collection and analysis.

**The Recovery Team recommended that the 24 remaining takes on the tagging permit for adult females at Laysan Island be used to implant PIT tags and attach Temple Tags® on 24 adult females. The Recovery Team further recommended that females previously tagged with Temple Tags would also receive PIT tags this year and concurred with Gilmartin that weaned pups should be marked with PIT tags and Temple Tags at all islands in 1992.**

Mediterranean Monk Seal Cooperative Work - Gilmartin reported on his cooperative work with Albert Österhaus in the evaluation of a vaccine for phocid distemper. Vaccine from a killed virus was used to treat four Hawaiian monk seals. Examination of blood titers showed that monk seals do not respond as well as harbor seals or grey seals to single inoculations of this type of vaccine.

Budget - As noted above, the Hawaiian monk seal research task at the Honolulu Laboratory will receive $445.3k as an add-on for FY 92 in addition to the $255k base for the program. This should allow the following tasks and projects to be accomplished for the 1992 field season:

1. Monitor all five major population sites (Kure, Pearl and Hermes, Lisianski, Laysan, French Frigate Shoals) and Midway.

2. Conduct mobbing studies at Laysan and Lisianski and related captive research.

3. Remove up to 10 identified adult male mobbers from Laysan Island.

4. Introduce rehabilitated female yearlings to Midway.

5. Collect and analyze scats and spews.

6. Conduct satellite and radio tagging/dive recorder studies.

7. Screen poor condition immature seals for diseases at French Frigate Shoals.

8. Continue PIT tagging.

Other Business

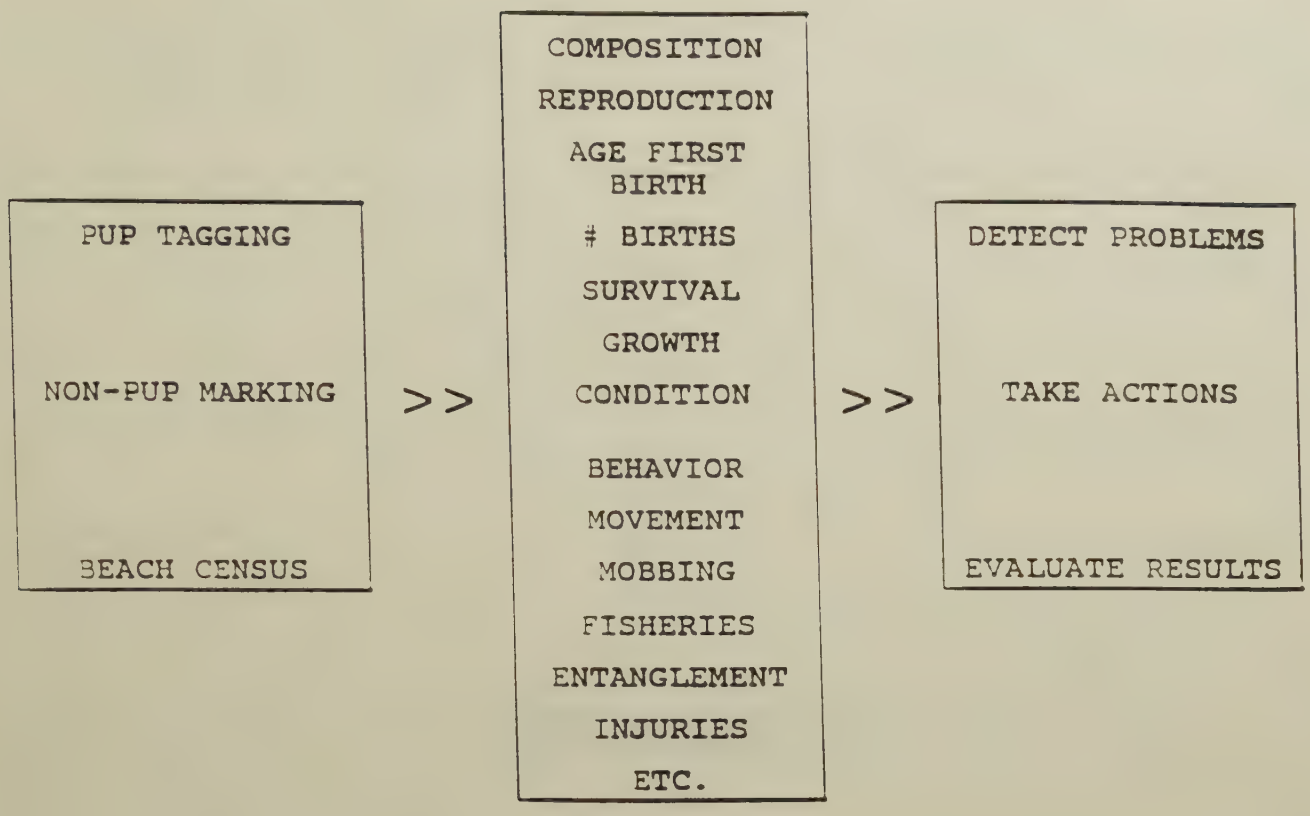
**The Team reviewed its current membership and concurred that the size of the Recovery Team and the expertise of its members was near optimal. If additional expertise is needed, then individuals with the necessary expertise would be invited to participate in future meetings of the Recovery Team.**

**The Team recommended that NMFS issue a contract for a consultant to look at perturbations in oceanographic conditions and how it may or might have affected productivity. The Team would like to have the consultant address the Team at the next meeting.**

It was noted that a mobbing workshop to examine behavioral and genetic issues will be scheduled after the summer data are worked up from the 1992 season.

The next Recovery Team meeting was tentatively scheduled for the week of December 2, 1992 in Honolulu. Adjustments in the dates may be necessary depending on the schedules of the Team members.

cc: Recovery Team members




**Hawaiian monk seal management:**
Critical information provided by population monitoring.

Figure 1.

# APPENDIX B

MINUTES FROM THE HAWAIIAN MONK SEAL RECOVERY TEAM MEETING
4-5 JANUARY 1993, SEATTLE, WA

A meeting of the Hawaiian Monk Seal Recovery Team was held at the National Marine Mammal Laboratory, Northwest and Alaska Fisheries Science Center, Seattle, WA on 4-5 January 1993. In attendance were R. Brownell, R. DeLong, D. DeMaster (chair), L. Eberhardt, W. Gilmartin, A. Johnson, and I. Stirling. P. Kawamoto and G. Nitta where not able to attend. B. Becker, M. Craig, and T. Ragen from the SWFSC, Honolulu Laboratory attended and participated in the discussions. W. Perrin attended representing the Marine Mammal Commission. The agenda for the meeting is given in Appendix 1. Recommendations from the meeting are summarized in Appendix 2.

Introductory comments were provided by Gilmartin. DeMaster asked Perrin to formally thank the U.S. Marine Mammal Commission for providing travel support for non-government Recovery Team members. Further, DeMaster acknowledged that Becker and Craig paid their own travel costs to attend the meeting. Finally, DeMaster apologized to Team members for any inconveniences related to the short notice of having to cancel the originally scheduled Team meeting (2-3 December 1992 in Honolulu) and reschedule the meeting to 4-5 January in Seattle.

By-Island Summary of Population Status

Ragen summarized the status of each subpopulation (hereafter referred to as an island population). Most of the information presented during this review was taken directly from a draft report by Ragen, "Status of the Hawaiian monk seal in 1992." In response to a previous comment by Eberhardt, Ragen presented both the long term perspective of status (i.e., 1950s through 1992) and the short term perspective of status (i.e., 1988 through 1992). In summary, the island populations at French Frigate Shoals and Laysan have decreased since 1988; while the populations at Pearl and Hermes, and Kure have increased. The island population at Lisianski was stable since 1988. It was noted that the estimated number of deaths due to mobbings at Laysan Island in 1992 included three adult females (total mobbing related deaths were projected at 10). There was no census information for the Necker population in 1992, while 5 births were reported at Nihoa in 1992. The population at Midway has only recently been monitored, and therefore, trends in abundance are unknown. The island population at Midway prior to the introduction of 20 females was estimated to include a maximum of 20 individuals. At French Frigate Shoals, the population increased at approximately 8% per year between 1956 and 1976 and then decreased at an annual rate of 7% per year between 1985 and 1992. During the recent decline at FFS, the age group that

showed the sharpest decrease in numbers was the juvenile age group (i.e., 1-3 year old animals).

Ragen also presented a summary of the movement and diving data from three subadult males instrumented with satellite tags at FFS in September 1992. All of the at-sea positions were within 100km of FFS. A majority of the at-sea positions were within 20km of FFS and to the north of Tern Island. Concerning diving behavior, it was noted that almost all of the 7379 recorded dives were to a depth of less than 76m and that dives made in the evening hours were generally shallower than dives made during the day. Finally, Ragen summarized the diving behavior of 11 animals that were instrumented with time-depth recorders (TDRs) at Laysan Island in 1992. At Laysan, the maximum depth of dive was slightly in excess of 200m. Depth of dive frequencies were distributed bimodally with peaks at 30m and 60m.

Hawaiian Islands Marine Ecosystem Workshop

Gilmartin and Ragen summarized the proceedings of the Hawaiian Islands Marine Ecosystem workshop held in Honolulu, HI in December. It appears that a large-scale shift in the North Pacific gyre (NPG) to the south had occurred in the 1970s and 1980s. This shift likely resulted in, among other things, a decrease in surface temperatures and an increase in primary production. Recently, the NPG seems to have shifted back to a more northerly position, resulting in decreased productivity in the Hawaiian Islands. Information presented on the productivity of several upper level predators (e.g., two species of sea birds, monk seal, and spiny lobster) was consistent with the hypothesis that the marine productivity of at least the central Hawaiian Archipelago had decreased since the late 1980s. It was noted that the time series of data was simply too recent to capture the results of the initial movement of the NPG to the south. Further, it was noted that few data were available on relative changes in the productivity of primary and secondary producers in the Hawaiian Islands over the last three decades. The Recovery Team recommended that an analysis of available oceanographic data pertaining to or relevant to waters around the Northwest Hawaiian Islands be completed. The Team noted that the Service has several experts in the field of biological oceanography (e.g., Drs. Paul Fiedler, Mike Dahlberg, and Mike Laurs) and encouraged the Director, SWR, to solicit input from experts both within and outside the Service. The Team also discussed the possibility of testing the "environmental regime" hypothesis for explaining the recent decline in monk seals at FFS with data concerning monk seal food habits (i.e., analysis of scats, fine structure in teeth, etc.) and changes in the abundance of monk seal prey. Gilmartin and others noted several problems in these approaches.

FFS Population Status and Relocation Program to Midway

Gilmartin summarized recent activities concerning the rehabilitation of animals from FFS and the relocation of animals to Midway. A report summarizing the findings was distributed. By the end of 1992, 13 of the 21 animals relocated from FFS to Midway were still alive. Gilmartin noted that all of the translocated animals were screened for transmission of possible disease vectors. Low titers for Leptospira were reported, but this finding was considered non-threatening to the monk seal population at Midway. Similarly, positive findings for some species of internal parasites and Salmonella spp. were considered non-threatening. Gilmartin added that the decision to by-pass the step, whereby animals are first moved to Honolulu from FFS prior to moving to Midway, was skipped on this October relocation. Gilmartin suggested that improved veterinarian care at Midway with allowance for temporary transfer of sick seals to Honolulu for more intensive care as needed may improve the survival of relocated animals. The Team concurred with this suggested scheme. Further, weaned pups were found to handle the stress of the relocation and introduction to a new environment considerably better than animals two years old and older. Perrin commented that the success of this relocation program was considerably less than the FFS-Kure Island relocation program. Gilmartin responded that future relocations may only involve emaciated weaned pups and that this would likely improve the rate of survival. DeLong recommended that the growth rate of translocated pups and pups born at Midway be compared to aid in evaluation of the factors responsible for mortality in relocated pups. In addition, DeLong and Johnson noted that the sex ratio of the FFS population should be monitored closely because of the potential for increasing the percentage of males in the population following the relocation of female monk seals to Midway.

Analysis of Population Data and Information Needs

Ebernardt led the discussion on analysis of population data, which was based on a draft background document circulated at the meeting. Eberhardt noted the following: 1) discontinuing the annual monitoring program for each island population would irreparably damage our ability to determine survival rates of monk seals, 2) each island population must be managed with information from that specific population because all of the sites have different population characteristics, 3) it is essential that the analysis of existing data be brought up to date, for without this knowledge it will not be possible to improve data collection methods or identify additional information that should be gathered. He recommended that population models be developed for each island population and that a comprehensive analysis of methods of population estimation and survival be undertaken. A discussion of how to stream-line

data collection and editing followed. Ragen commented that the research team had recently begun direct computer-data entry and had eliminated a number of data fields that were considered redundant. He added that an annual summary of field results will be prepared and that the data reporting format for each island will be standardized.

Research and Management Recommendations at FFS

DeMaster led the discussion concerning research and management recommendations at FFS. It was noted that Gilmartin would use this discussion to help focus the development of a research and management plan for monk seals at FFS. The following ideas were suggested with priorities attached to each activity, where I means "highest priority and should be done," II means "important and should be done," and III means "priority, but not essential:"

Priority I:

1. Continue monitoring population annually (beach counts, births, sex ratio, age composition, survival, etc.).

2. Continue tagging weaned pups.

3. Follow up on ecosystem workshop findings and expand oceanographic studies as they relate to monk seal population dynamics.

4. Initiate inter-island comparison of behavioral data, specifically multi-island atolls with single islands sites.

5. Monitor growth rates of emaciated pups at FFS and compare to growth rates of pups born at Midway and those relocated from FFS to Midway.

6. Compare rates of growth for juveniles at FFS and Laysan.

7. Continue disease monitoring at FFS.

8. Develop "start/stop" criteria for relocating animals to Midway. Consider relocating some males.

9. Continue relocation of rehabilitated pups to Midway.

10. Continue restoration of habitat at Tern Island.

11. Increase efforts to locate tagged animals at Nihoa and Necker Islands.

12. Continue release of animals entangled in derelict fishing gear and marine debris.

13. Continue monitoring fishery interactions (SWR: place observers in NWHI).

14. Mitigate, as possible, harassment of monk seals during surveys for seabirds and sea turtles, and vice versa (utilize Section 7 or permit process, as appropriate).

15. Retag animals that have lost previously applied flipper tags.

16. Evaluate the degree to which tag loss may bias estimation of survival and population size.

17. Continue monitoring pup production and aggressive interactions.

18. Continue necropsy program and expand collection of tissues (e.g., National Tissue bank program).

19. Evaluate utility of applying larger PIT tags remotely.

20. Evaluate patterns in reproduction and compare with other islands.

Priority II:

1. Increase efforts to study foraging behavior.

2. Develop population model for FFS population and complete a PVA comparing persistence times for various manipulations.

3. Compile osteologic collection from FFS.

4. Evaluate potential for using remote sensing to monitor population.

Priority III:

1. Initiate analysis of genetic markers at FFS.

2. Evaluate potential for historical data on monk seals at Johnston Island.

3. Consider rehabilitating female pups on site at FFS (i.e.,

Alternative Recovery Team Meeting Schedule

The final agenda item discussed on the first day was item #10, which was led by Gilmartin. He noted that Dr. Boehlert had questioned whether an annual Recovery Team meeting was really necessary and had suggested using an alternate year schedule of a recovery team meeting rotating with meetings to address a specific topic, utilizing, as may be appropriate, other than Team expertise. After some discussion, the Recovery Team recommended continuing the annual schedule of meetings. Because the interaction among Team members and the monk seal research staff is considered critical to the overall success of the program, Team meetings should be held in Hawaii. Team members concurred that the familiarity of the monk seal staff with the field data and their presence at the Team meetings was important because it increased the Team's ability to ask detailed questions concerning monk seals. Because the field schedule for monk seal research begins early in the calendar year and because the opinions of the Team often affect the type of field work that is planned, early December is optimal for a meeting time. It was noted that additional workshops should be planned and held on an "as-needed" basis.

Mobbing Research Status and Recommendations

Gilmartin led the discussion concerning how to resolve the male-mobbing problem at Laysan. In 1992, he noted that most of the mobbing related deaths were in April (whereas in a typical year they occur between May and June). Further, 7 known deaths (2 adult females) and 3 "assumed" deaths (1 adult female) were related to mobbings. Gilmartin then presented a summary of the feasibility study to evaluate the potential for resolving the male mobbing problem at Laysan by "simulating" the removal of aggressive males by using a testosterone-suppressing drug. The experimental design and "start/stop" criteria developed at the previous year's Team meeting were discussed (Appendix 4). Gilmartin noted that the discriminant analysis used to identify aggressive males was not as useful as hoped and that it was difficult to find enough suitable males for treatments and controls. He added that there were no acute behavioral responses towards or by any of the 10 adult males treated with the drug, but that the blood tests of drugged animals indicated that testosterone levels had been reduced to levels approaching zero. Finally, it was noted that 10 adult males were not removed as recommended in the research protocol because of a lack of funding and an inability to locate facilities to take the seals.

DeMaster led the discussion concerning how to proceed with the evaluation of whether or not to permanently remove male monk seals from Laysan Island. The Team discussed the following options: 1) drug 50% of the males in 1993, 2) remove 50% of the males, 3) drug 10 males and remove 10 males, 4) drug 25 males and

remove 25 males, and 5) do nothing in 1993. The cost and relative benefits of each option were discussed. After a lengthy discussion, the Team recommended that up to 50 adult males at Laysan Island be injected with a testosterone-suppressing drug in 1993. Further, the Team recommended that if funding for this project was not available (estimated cost $100K) in FY-93, that a minimum of 10 adult males should be removed to captivity. The Team further recommended that funding should be made available to increase efforts to identify adult males that participate in mobbings at Laysan Island and to analyze behavioral data from all islands to allow for inter-island comparisons. Perrin commented that he thought a priority should be placed on actually observing a minimum number of mobbing events. In this way, specific individuals could be identified and information on how mobbing events are initiated might be determined. Gilmartin commented that the low frequency of mobbing events together with their uncertain location makes it very difficult to plan a study as proposed by Perrin. In some past years a high staff effort has been directed at locating mobbing events, but little has resulted from it.

Development of Protocol for Responding to Emergencies

Gilmartin introduced the topic of developing a protocol for responding to emergency situations and possibly pursue permit authority for such in a manner similar to the process used to authorize takes during "die-offs". An example of such a situation was the adult male monk seal at FFS that was observed killing pups. The Team concurred with the need to take action quickly in these situations and expressed concern that, given the small size of some of these island populations, even the loss of a few animals could significantly reduce population viability. Therefore, no significant delays in making decisions to remove animals or other managerial actions should occur. The Recovery Team recommended that, as necessary, the leader of the Marine Mammal Research Program at the Honolulu Laboratory be authorized to directly solicit opinions from Recovery Team members in emergency situations if that is necessary to obtain authorization to take action.

Permit Status and Needs

DeMaster led the discussion concerning permit status. Gilmartin noted that the general permit that authorizes research on monk seals expires in December 1993. DeMaster requested that Gilmartin summarize the status of all NMFS permits for monk seals in a table, which would be included as an appendix to the minutes of this meeting (Appendix 3).

Other Business

Concerning the suggestion to update the existing recovery plan, the Team considered such an action unnecessary at this time. Rather the Team encouraged Gilmartin to update the 1991-1993 workplan for monk seals through 1996. Also, Gilmartin noted that the proposed research by Drs. Katherine Ralls and Tony Starfield to evaluate the probability of success for various approaches to resolve the mobbing problem had not been funded, but some work was on-going. Brownell commented that in the status report prepared by Ragen that he should be consistent in the use of terms like "population" and "species". Gilmartin distributed an updated monk seal program publication list (Appendix 4).

The next Recovery Team meeting was tentatively scheduled for the week of December 2, 1993 in Honolulu. At that meeting, listing and delisting criteria under the ESA and MMPA will be discussed, among other items.

The Recovery Team voted to give letters of appreciation to Karl Kenyon, Dale Rice, and Cliff Fiscus for their pioneering work on the Hawaiian monk seal.

APPENDICES:

Appendix 1. Meeting agenda

Appendix 2. List of recommendations from 4-5 January 1993 meeting.

Appendix 3. Summary of permits

Appendix 4. List of publications.

Appendix 1.

## HAWAIIAN MONK SEAL RECOVERY TEAM MEETING
## AGENDA

Dates: 4-5 January 1993
Venue: National Marine Mammal Laboratory
Participants: DeMaster (Chair), Brownell, DeLong, Eberhardt, Gilmartin, Johnson, Kawamoto (absent), Stirling, SWR - Nitta (absent)
MMC observer- Perrin

### AGENDA
0900 Monday 4 January 1993

1. By-Island (ex FFS) summary of 1992 Population Status and Recovery Needs (45 min)

2. FFS summary of 1992 Population Status and Recovery Needs (30 min)

3. Hawaiian Islands Marine Ecosystem Workshop (30 min)

4. FFS disease survey and seal collection, rehabilitation, and relocation efforts to Midway (2 hr)

5. Population Data Analysis Needs and Recommendations (1 hr)

6. FFS Research/Management Recommendations (1 hr)

0800 Tuesday 5 January 1993

7. Mobbing Research Status and Recommendations (2 hr)

8. Development of Protocol for Responding to Emergencies (e.g., aggressive males, emaciated animals, etc. 30 min)

9. Permit Status, Needs, and Recommendations

10. Alt. year schedule of general meeting and meeting to address specific topics (GWB suggestion).

11. Discussion of need to update existing Recovery Plan (30 min)

12. Review of recommendations to Regional Director

Appendix 2.

HAWAIIAN MONK SEAL RECOVERY TEAM RECOMMENDATIONS
4-5 JANUARY 1993

**1. The SWR should secure funding for annual Recovery Team meetings in Hawaii by early November.**

To be an effective advisory body to the Director, SWR, Recovery Team members believe it is necessary to meet annually at a minimum. Scheduling is best accomplished by agreeing to next year's meeting date a year in advance. Because the field schedule for monk seals begins early in the calendar year and because of the minimum 90-day period to get MMPA permits, early December seems optimal for meeting. This timing also enables assembly of the previous field season's data for presentation to the Team. Finally, meeting in Hawaii allows the Team greater interaction with the monk seal staff. This interaction is extremely important because it allows the Team greater familiarity with recently available data, greater access to unanticipated data needs, and the opportunity to work directly with the monk seal staff. In addition, the Team recommends that the SWR allocate funds to cover the travel expenses of all of the members of the Recovery Team, as opposed to only funding members who do not work for the Federal government.

**2. The level of support for the monk seal recovery program in FY-93 should be sufficient to allow monitoring of the five main breeding populations, relocation of animals from French Frigate Shoals to Midway, and resolution of mobbing problem at Laysan Island.**

Recovery Team members are concerned that the probable level of funding for FY-93 will be insufficient to support the basic three programs that have been identified as being critical to the recovery of monk seals in Hawaii.

**3. Funding in FY-93 should be made available to increase efforts to identify adult males at Laysan Island involved with mobbing and to analyze behavioral data from all islands.**

The Recovery Team notes that efforts to identify adult males at Laysan Island involved with mobbing were not entirely successful in 1992. Therefore, the Team recommends that additional effort be directed at analyzing behavioral data from Laysan and the other breeding islands to address the question of how to identify "aggressive" males. If possible, the Team recommends that a workshop be organized in 1993 to review the findings of the analysis of the behavior data and to report the results of this workshop at the December 1993 Recovery Team meeting.

**4. Up to 50 adult males at Laysan Island should be injected with a testosterone-suppressing drug. Further, the necessary funding and permits to accomplish task should be secured.**

Recovery Team members were informed that the probable funding level for FY-93 is such that the funding necessary to support the resolution of the mobbing problem at Laysan Island (ca $100K) is not available (i.e., funding to support injecting up to 50 males with a testosterone-suppressing drug). Further, the Team was extremely disappointed to hear that funding in FY-92 was not available to remove 10 males from Laysan Island, as recommended. At this point, the Team is frustrated that very little has been done to date to resolve the mobbing problem at Laysan Island and, if the level of support for the monk seal recovery program in FY93 is not increased, nothing will be done in FY93. At a minimum the Team recommends that, if funding to drug up to 50 adult males is not available, 10 adult males should be removed to captivity.

**5. Placing observers on long-line and bottom-fish fishing vessels in the Northwestern Hawaiian Islands should continue.**

The Recovery Team continues to be concerned over the potential for direct monk seal-fishery interactions that may be adversely affecting the monk seal population. Information on the extent to which monk seals either follow or interact with commercial fishing vessels in the vicinity of French Frigate Shoals is needed to evaluate the magnitude of this problem.

**6. It should be appropriate for the Leader of the Marine Mammal Research Program, Honolulu Laboratory, SWFSC, to solicit opinions directly from the Recovery Team in emergency situations.**

The Recovery Team commends the Service for its quick response, after identifying a male monk seal at French Frigate Shoals that was responsible for the deaths of several young seals. The Team acknowledges that it serves at the request of the Director, Southwest Regional Office. However, the Team recommends that in certain circumstances the Regional Director should allow the head of the monk seal research program to solicit an opinion directly from members of the monk seal Recovery Team. The Team further recommends that the staff of the Southwest Center, Region, and chair of the Recovery Team consult on specific criteria for emergency response.

**7. Enforcement agent/s from the SWR should be stationed at Kure Atoll to monitor loran station clean up operations by the Coast Guard to ensure that seals are not disturbed.**

The Recovery Team is concerned with the potential for disturbance to monk seals at Kure Atoll, especially lactating females with young pups, caused by the final disposal operations

scheduled for this summer. As recommended at last year's meeting, the Team recommends that the SWR, NMFS monitor the station clean-up to ensure that seals are not disturbed.

**8. A comprehensive review of findings from the workshop on variation in the marine environment and ecosystem around NWHI should be conducted. Further, additional efforts are needed to provide the information necessary to evaluate the extent to which large- and mesa-scale oceanographic events are impacting monk seals in the Northwestern Hawaiian Islands.**

The Recovery Team recommends that an analysis of available oceanographic data pertaining to or relevant to waters around the Northwest Hawaiian Islands be completed. The Team notes that the Service has several experts in the field of biological oceanography (e.g., Drs. Paul Fiedler, Mike Dahlberg, and Mike Laurs) and encourages the Director to solicit input from the Service's experts and others.

Appendix 3.

**Summary of 1992 Activities Conducted Under Marine Mammals and Endangered Species Permit No. 413**

Two Hawaiian monk seals collected under authority of Marine Mammals and Endangered Species Permit No. 413 remain in permanent captivity (YT05 and TP15). No research was conducted on these seals in 1992. Both seals remain in good health at the Waikiki Aquarium.

## Summary of 1992 Activities Conducted Under Marine Mammals and Endangered Species Permit No. 482

Four adult male Hawaiian monk seals collectd under authority of Marine Mammals and Endangered Species Permit No. 482 remain in captivity. Two studies were conducted on these seals in 1992: 1) Continued assessment of the effects of a testosterone suppressing drug; and 2) Testing of instrument attachment prior to use of the procedure on seals in the wild.

### Assessment of Testosterone Inhibiting Drug

Studies in 1991 demonstrated that Decapeptyl® could be used to suppress serum testosterone levels in Hawaiian monk seals. In 1992, studies centered on the effects of this drug on the behavior of male seals. Two adult males were given limited physical access to two female monk seals (one mature, one immature), and their behavior was regularly monitored for two weeks to determine which male seal would prove dominant. Neither showed a significant dominance over the other. One seal was then injected with 12 mg of Decapeptyl, and observations continued for several weeks. Data showed the treated seal became subordinate to the non-treated seal.

### Testing of Field Instruments

Prior to use in the field, instrument mounting and antenna configurations were tested on captive adult male seals. Dummy instrument packs were affixed with marine epoxy to the dorsal pelage of two seals to determine retention times. These packs also had a modified antenna configuration, designed to reduce the chances of breakage on hard substrate. Using information derived from the captive trials, field application of the instruments in the fall of 1992 was successful.

## Summary of 1992 Activities Conducted Under Marine Mammals and Endangered Species Permit No. 555

One rehabilitated male Hawaiian monk seal (ID YL03), captured under authority of Marine Mammals and Endangered Species Permit No. 555, remains in permanent captivity. No research was conducted on this seal in 1992. The animal remains in good health at Sea Life Park, Hawaii.

**Summary of 1992 Activities Conducted Under Marine Mammals and Endangered Species Permit No. 591**

Marine Mammals and Endangered Species Permit No. 591 authorizes instrumentation of Hawaiian monk seals with time-depth recorders and radios. No activities were conducted in 1992 under authority of said permit.

Special condition B.6. of this permit requires a written request to continue research into a second year (first year research was completed in 1988) so F/PR will be notified prior to any resumption of the authorized research.

**Summary of 1992 Activities Conducted Under Marine Mammals and Endangered Species Permit No. 657**

Marine Mammals and Endangered Species Permit No. 657 authorizes take of Hawaiian monk seals under several different categories and sections. Activity summaries are presented below by appropriate section.

Per Special Condition B.6., permission is hereby requested to continue activities under this permit in 1993.

A.1.a. Census Seals

This section authorizes take by inadvertent disturbance of an unspecified number of seals during censuses or other observational activities. The following summarizes such activities.

NIHOA ISLAND: Personnel from the University of Hawaii were present 14-29 July. Acting as designated agents of the Southwest Fisheries Science Center (SWFSC), they conducted censuses of seals and resighted tagged animals. Mean counts are still being compiled.

FRENCH FRIGATE SHOALS: Field activities were conducted at French Frigate Shoals during 25 March-7 October. Eleven atoll-wide censuses were conducted, resulting in a mean count of 174 seals, excluding pups. This number represents a continuation of a decline first observed in 1990. The number of pups born totalled 102, an increase from 82 births in 1991. Debris capable of entangling wildlife was destroyed, and two entangled seals were freed.

LAYSAN ISLAND: Field activities were conducted at Laysan Island during 20 March-26 July. Intensive observations were made of adult male seals as part of an experiment to assess the efficacy of a testosterone suppressant on seal behavior. In addition to these observations, 27 island censuses were completed, resulting in a mean count of 75 seals, excluding pups. Births totalled 37, the second highest recorded on Laysan since 1983. Eleven mortalities were documented, seven of which were attributable to mass attacks ("mobbing") by adult male seals. Debris was cataloged and destroyed, and one seal entangled by a plastic strap was freed.

LISIANSKI ISLAND: A field camp was in place at Lisianski Island during 21 March-17 July. A total of 29 censuses were completed, resulting in a mean of 71 seals, excluding pups. Births totaled 23, an increase from 1990 and 1991. Four mortalities were documented, with one female having died from mobbing injuries. Eight seals were observed entangled, seven of which were freed (the eighth freed itself). Debris was cataloged and destroyed.

PEARL AND HERMES REEF: Field activities were conducted at Pearl and Hermes during July 20-25. During this brief period, five censuses of the entire atoll were conducted, resulting in a mean count of 75 seals, excluding pups. Twenty-six pups were observed, representing a high for total births documented at Pearl and Hermes. A male pup was found entangled in debris and was released. Debris was destroyed, but not cataloged.

MIDWAY ISLANDS: Field activities were conducted at Midway Islands intermittently from April 28 to December 3. Personnel of the U.S. Fish and Wildlife Service, as designated agents of the SWFSC, also made observations and conducted censuses during the entire year. Census data are still being tabulated, but 10 atoll-wide counts through the end of August resulted in a mean count of 8.2 seals. Spit Island, the main pupping location, was cleared of hazardous debris.

KURE ATOLL: Field activities were conducted on Kure Atoll during March 8-July 17. Fifteen atoll-wide censuses resulted in a mean count of 34.3 seals, excluding pups. Debris was inventoried and destroyed, and a plastic band was removed from one seal which was found entangled. Project personnel also monitored Coast Guard activities involving removal of the 625-ft loran tower, and intentionally harassed four seals from potentially hazardous areas during demolition.

A.1.b. Monk Seal Mass Mortality Response

This section authorizes take of 156 seals by various means should an outbreak of apparent illness or other condition threaten one or more populations. In the spring of 1992, many thin or emaciated juvenile seals were sighted at French Frigate Shoals. An assessment effort was initiated, and, as authorized by A.1.b.II., nineteen (19) immature seals were restrained for blood sampling and collection of bacterial and viral culture swabs. Remaining take in this section is one (1) seal.

Results from the above effort indicated that the seals were not suffering from any acute disease process, but that their condition likely resulted from undernourishment. Accordingly, several of these seals were subsequently captured for rehabilitation under provisions of Permit No. 707, as modified May 5, 1992.

A.1.c. Kure Atoll Monk Seal Pup Temporary Captive Maintenance

This section authorizes take at Kure Atoll over 4 years by capture, tagging, and temporary maintenance of up to 24 seals (6/yr) and take of an additional 32 seals (8/yr) by capture, tagging, and release.

In 1992, temporary maintenance of pups at Kure Atoll was discontinued. Pups were still tagged, however. Following is a summary of total take:

| | Captive Maintenance | Tag and Release |
|---|---|---|
| Authorized: | 24 | 32 |
| Previously Taken: | 12 | 15 |
| Taken in 1992: | 0 | 13 |
| Total taken: | 12 | 28 |
| Remainder: | 12 | 4 |

A.1.d. Collection of Hawaiian Monk Seals for Rehabilitation and Release to the Wild

This section authorizes take of 32 seals (8/yr) for temporary maintenance in captivity, rehabilitation, and release.

Seven (7) underdeveloped female seal pups were collected in 1992 from French Frigate Shoals for rehabilitation. All were transported to Honolulu. One seal died in Honolulu approximately 3 weeks after capture. Death resulted from acute abdominal hemorrhage following a torsion of the intestine. As of 21 December, all remaining 6 seals were in good condition. A summary of take is as follows:

| | |
|---|---|
| Authorized: | 32 |
| Previously taken: | 16 |
| Taken in 1992: | 7 |
| Total taken 89-92: | 23 |
| Remainder: | 9 |

Also in 1992, the six (6) seals collected as pups in 1991 were released at Midway Islands after reaching a weight comparable to their counterparts in the wild.

A.1.e. Tag Hawaiian Monk Seal Pups

This section authorizes take by restraint and tagging up to 1,100 weaned Hawaiian monk seal pups (220/yr) at all Hawaiian Island locations except Kure Atoll (which is authorized in A.1.c.). Per authorization of 16 May 1991, up to 840 of these pups may also be tagged with Passive Integrated Transponders (PITs) as well as the heretofore used Temple Tags®. Take under this section is as follows:

| | Temple Tags | PITs |
|---|---|---|
| Authorized: | 1,100 | 840 |
| Previously taken: | 402 | 115 |

| | | | | |
|---|---|---|---|---|
| **Taken in 1992:** | | | | |
| Midway Is.: | 1 | | 1 | |
| Pearl & Hermes: | 23 | | 16 | |
| Lisianski I.: | 21 | | 21 | |
| Laysan I.: | 32 | | 31 | |
| French Frigate: | 90 | | 67 | |
| Total 1992 take: | | 167 | | 136 |
| Total taken 89-92: | | 569 | | 251 |
| Remainder: | | 531 | | 589 |

A.1.f. Tag and Mark Seals for Mobbing Study

This section authorizes take of up to 250 seals by tagging and marking at Laysan. Up to 200 adult/subadult males may be taken by tagging and marking, and up to 50 adult females may be taken solely by marking. As authorized via letter October 20, 1990, males may be tagged with PITs as well as Temple Tags. As authorized in a letter of clarification to permit no. 707 June 22, 1990, up to 10 of the adult males authorized in this section may also be blood sampled.

In 1992 three (3) adult male seals at Laysan were captured, restrained, sedated, and blood sampled, and 36 males were taken by marking only. Summary of total take under this section follows:

| | | |
|---|---|---|
| Authorized: | 250 | |
| Previously taken : | 204 | (including 50 adult females) |
| Taken in 1992: | 39 | |
| Total taken 89-92: | 243 | |
| Remainder: | 7 | (males only) |

A.1.g. Mark seals

This section authorizes take by temporary marking of up to 750 seals at any Hawaiian Islands location. Take under this section is as follows:

| | | |
|---|---|---|
| Authorized: | | 750 |
| Previously taken: | | 518 |
| Taken in 1992: | | |
| Kure Atoll: | 6 | |
| Midway I.: | 15 | |
| Lisianski I.: | 175 | |
| Laysan I.: | 35 | |
| French Frigate: | 1 | |
| Total taken 89-92: | | 750 |
| Remainder: | | 0 |

All seals were marked with commercial hair lightener while they were sleeping.

A.1.h. Collect Biopsy Samples

Except for tissue plugs collected during tagging, no biopsy samples were collected in 1992.

**Summary of 1992 Activities Conducted under Marine Mammal and Endangered Species Permit No. 707**

Marine Mammals and Endangered Species Permit No. 707, as amended July 31, 1992, authorizes take of Hawaiian monk seals under several categories and sections. Activity summaries are presented below by appropriate section.

Per special condition B.7., permission is hereby requested to continue activities under this permit in 1993.

A.1.a. Weigh, Measure, and Mark Seals

This section authorizes capture, weighing, and measuring of up to 300 weaned pups and immature seals. Modification No. 1 allows temporary marking of up to 150 of these seals. Take in 1992 was as follows:

| | | |
|---|---|---|
| Authorized: | | 300 |
| Previously taken: | | 282 |
| Take in 1992: | | |
| Laysan I.: | 18 | |
| Total: | 18 | |
| Total taken 1990-1992: | | 300 |
| Remainder: | | None |

Other seals were weighed and measured under authority of MMPA/ESA Permit No. 778 and are included in the summary for that permit.

A.1.b. Transfer Weaned Pups; Blood Sample Adult Males

1) Transfer five weaned pups: all five weaned pups were taken in 1990, hence no take remained and no seals were so taken in 1992.

2) Blood sample eight adult males at Kure Atoll: no seals were taken for this purpose in 1992. Remaining take is therefore six seals (two were taken in 1990).

3) Blood sample 10 adult males at Laysan Island: Per clarification dated June 22, 1990, Permit 707 authorizes blood sampling of up to 10 adult males already authorized by Permit 657 to be taken for tagging at Laysan Island. Three seals were so taken in 1992, and are included in the summary for Permit 657.

A.1.c. Female Seals in Permanent Captivity

No take remains in this section, as two females, YL79 and Y634, were captured in 1990 and 1991. Both of these females remained in good health at Sea Life Park through 1992.

Research on YL79 in 1992 continued a project initiated in 1991 to ascertain the animal's estrous cycle. Serum progesterone

and estrogen were monitored. These data were derived initially from blood samples, but after a short period to garner baseline data, information was obtained solely from saliva and urine samples.

Baseline sampling was conducted on seal Y634 to confirm that she was still sexually immature. This being the case, no further monitoring was conducted.

Both females were used in an experiment to test the effectiveness of a testosterone suppressant in reducing aggressive behavior among (captive) male seals. This required no handling of the females, which, for their part, remained in their holding areas while two adult males were moved to adjacent pens. Research protocol involving the adult males is included in the summary for Permit 413.

A.1.d. Mark Nursing Pups

This section authorizes temporarily marking 80 nursing pups at Laysan Island. Remaining take in 1992 was 70 seals. In 1992, 22 nursing pups were temporarily marked at Laysan Island, and 21 were marked at Lisianski Island. Remaining take in this section is therefore 27 seals.

A.1.e. Tag Immature Seals

This section authorizes tagging of juvenile and sub-adult seals at any location, and adult seals at Midway. Take is summarized below:

| | | |
|---|---|---|
| Authorized: | | 275 |
| Previously taken: | | 48 |
| Take in 1992: | | |
| Midway: | 1 | |
| Pearl & Hermes: | 2 | |
| Lisianski I.: | 4 | |
| Total : | 7 | |
| Total taken 1990-92: | | 55 |
| Remainder: | | 220 |

A.2. Collect Seals for Rehabilitation and Relocation

This section, added as Amendment No. 1 on July 31, 1992, authorizes capture of up to 60 seals from French Frigate Shoals for rehabilitation and relocation to Midway Atoll. Twenty (20) seals (16 juveniles, 4 weaned pups) were taken in 1992. Their fates are summarized as follows:

| | |
|---|---|
| Released at FFS, no transfer: | 3 |
| Died in captivity at FFS: | 1 |
| Died in Honolulu: | 2 |
| Died in captivity at Midway: | 2 |
| Released at Midway: | 9 |
| Returned to Honolulu from Midway: | 3 |
| Total: | 20 |

The three seals returned to Honolulu for additional treatment and feeding to increase their weight. They will be transported to Midway and released in January, 1993.

**Summary of 1992 Activities Conducted Under Marine Mammals and Endangered Species Permit No. 711**

Marine Mammals and Endangered Species Permit No. 711, as amended February 25, 1992, allows take by flipper tagging of 60 adult female Hawaiian monk seals. Remaining take on this permit is 44 seals.

No seals were taken under authority of this permit in 1992.

Per special condition 6.a. permission is hereby requested to continue activities on this permit in 1993.

**Summary of 1992 Activities Conducted under Marine Mammal and Endangered Species Permit No. 729**

Permit No. 729, as modified March 24, 1992, authorizes take of up to 30 Hawaiian monk seals on Laysan Island for the purposes of evaluating the effects of Decapeptyl®, a testosterone suppressant, on the behavior of adult male seals. Take in 1992 was as follows:

Treatment Group: Ten adult male seals were captured, sedated with diazepam, equipped with an instrument pack, blood sampled, injected with 7.5 mg Decapeptyl, and released. An eleventh seal died during capture, after having been sedated, blood sampled, and administered one half the Decapeptyl dose. Eight of these seals were subsequently recaptured for collection of a second blood sample and removal of the instrument (though some had lost the instrument from the mounting pack). The two other treated seals have not been resighed since several weeks after the initial handling.

Treatment Control Group: Nine adult male seals were captured, sedated with diazepam, blood sampled, equipped with an instrument pack, and released. Eight of these seals were subsequently recaptured for collection of a second blood sample and removal of the instrument. The ninth seal disappeared several weeks after the initial handling.

Handling Control Group: Ten seals were captured, sedated with diazepam, blood sampled, and released. They were not recaptured.

Tissue samples from the seal which died were submitted for histopathological analysis, and results are pending. No gross abnormalities were noted during necropsy.

**Summary of 1992 Activities Conducted Under Marine Mammals and Endangered Species Permit No. 778**

Marine Mammals and Endangered Species Permit No. 778 authorizes take of 1200 Hawaiian monk seals under several different categories and sections. Activity summaries are presented below by appropriate section.

A.1. PIT tag seals

This section authorizes take of 1200 seals by injection of PIT tags, plus additional handling as specified in parts *a* to *f* below. In 1992, the Protected Species Investigation (PSI) learned that other researchers were experiencing an unacceptable failure rate of PIT tags which were applied remotely using a spring loaded syringe. The PSI therefore decided not to remotely apply any PIT tags to monk seals in 1992, pending resolution of apparent problems in the injection equipment. However, some seals were handled in accordance with authorizations *a* to *f* (see table 1):

a. Authorizes retaking all 1200 up to twice to reapply bleach marks after molt. No seals were taken under this provision.

b. Authorizes up to 300 taken by capture, weighing, and measuring. In 1992, 15 immature seals were weighed at Laysan Island and 42 were weighed at French Frigate Shoals (FFS), totalling 57. Remaining take is therefore 243 seals.

c. Authorizes up to 250 taken by temporary marking. In 1992, 143 seals were marked on Laysan Island under this authority. (Other seals were marked under authority of Permit No. 657 and are indicated in that summary). Remaining take is therefore 107 seals.

d. Authorizes up to 100 taken by retagging. In 1992, 27 seals were retagged with Temple Tags® to replace lost or worn tags. Remaining take is therefore 73 seals.

e. Authorizes up to 30 taken by capture, restraint, sedation, and sampling to assess for the presence of diseases. In 1992, no seals were taken for this purpose under authority of Permit No. 778. Prior to issuance of Permit No. 778, several seals were so sampled at FFS, as authorized by "Mass Mortality" provisions of Permit No. 657, and are included in the summary.

f. Authorizes up to four (4) taken by capture, restraint, sedation, and instrumentation with radio/satellite transmitter package. In 1992, three (3) adult male seals were instrumented at FFS.

A.2. Incidentally harass seals

This section authorizes incidental harassment of up to 500 seals while conducting activities authorized above. In 1992, precise records were not maintained detailing the number of seals harassed. However our best estimate is that 40 seals alerted to research activities and fled into the water as a result of weighing, instrumenting, or retrieving instruments from other seals in the vicinity.

Special Condition 2.a.

**Effects on Animals/Length of Instrumentation**

No adverse effects were noted on seals taken under provisions of this permit.

Of the 3 seals equipped with instruments per A.1.f., following is a table of instrumentation times:

| Seal No | Date Applied | Date Removed | Duration (days) | Comments |
|---|---|---|---|---|
| 1 | 9/15/92 | NA | min 106 | Still attached and transmitting 12/31/92 |
| 2 | 9/18/92 | 12/10/92 | 83 | Power loss on 11/24/92 |
| 3 | 9/20/92 | 12/9/92 | 81 | Still transmitting when removed. |

**Activities Planned for 1993**

A.1. PIT tag seals: Contingent upon resolving problems with failure of tags which are remotely injected, we tentatively plan to remotely inject seals with PITs in 1993.

A.1.a. Mark after PIT tagging: If seals are given PIT tags in 1993, we will mark them as authorized.

A.1.b. Weigh immature seals: We plan to continue to weigh immature seals at French Frigate Shoals and Laysan Island in 1993.

A.1.c. Temporarily mark seals: Marking seals (not necessarily ones with PIT tags) has proven to be a successful technique to facilitate identification from a distance, and will be continued in 1993.

A.1.d. Retag seals: We will continue to replace lost, worn, or broken Temple Tags in 1993.

A.1.e. Screen seals for diseases: It is likely that in 1993 the only seals screened for diseases at FFS will be animals authorized for take by capture, rehabilitation, and release under Permit 707. Therefore we do not anticipate any take under this section.

A.1.f. Attach instrument packs: We plan to similarly instrument seals at FFS in 1993, and will request a permit to cover additional take. The take of one seal which remains in this section is will likely be used.

# APPENDIX C

MARINE MAMMAL COMMISSION
1825 CONNECTICUT AVENUE, N.W. #512
WASHINGTON, DC 20009

20 December 1991

The Honorable William W. Fox, Jr., Ph.D.
Assistant Administrator for Fisheries
National Marine Fisheries Service, NOAA
1335 East-West Highway, Room 9334
Silver Spring, Maryland 20910

Dear Dr. Fox:

On 5 and 6 November 1991, the Marine Mammal Commission conducted a review of the National Marine Fisheries Service's Hawaiian Monk Seal Program. The agenda is attached. Without question, the Hawaiian monk seal program staff has made significant progress since the Commission's 4 and 5 December 1989 program review. Program improvements are particularly evident in population monitoring, captive maintenance and care, the Kure Atoll "head start" program, the pup capture, rehabilitation, and release program, and the analysis and publication of field and other research data.

A primary focus of the review was the allocation of effort to different program components. At present, the preponderance of effort, in terms of dollars and personnel, is devoted to documenting the status and trends of the population, analyses of relevant data and information, and general program support. While these activities are essential for providing a sound information base for decision-making, they do little to actually restore the species as opposed to documenting its condition. Review participants strongly believe that the information base has evolved to a point at which greater emphasis can and should be placed on work directly related to specific restoration tasks; they further believe that necessary funding is available to begin such efforts now. Among the actions discussed were: applying more effort to assessing resource needs and limitations through habitat and foraging studies; addressing male mobbing through a combination of approaches including behavioral research and, if at all possible, immediate action to mitigate injury to breeding females; continuing and, if possible and appropriate, expanding the pup capture, rehabilitation, and release program; improving the ability to promptly detect and mitigate or avoid adverse fishery interactions; and protecting habitat, including prey availability.

With regard to fisheries interactions, available information on Hawaiian monk seal offshore demography, foraging and other

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habitat requirements, and the species' numerical and functional relationships with other components of the marine ecosystem is inadequate. It does not allow one to predict how Hawaiian monk seals have been or are likely to be affected by commercial fisheries and other activities in the North Pacific. Likewise, available baseline information and monitoring programs are insufficient to detect and determine the causes of even catastrophic changes in the distribution, abundance, and productivity of monk seal prey species.

In this regard, reviewers acknowledged the need to include habitat use and fisheries interaction studies in the Hawaiian monk seal recovery program. Therefore, the Marine Mammal Commission recommends that: (1) the ongoing Hawaiian monk seal population monitoring program be continued, taking into account observations and recommendations made elsewhere in this letter; (2) satellite-linked tagging and tracking programs to assess, among other things, foraging range and offshore distribution of Hawaiian monk seals be developed immediately for implementation on a pilot program basis this coming field season; (3) an assessment of available information on Hawaiian monk seal prey species be undertaken and, based on this assessment, studies on the distribution, abundance, and productivity of monk seal prey species be developed and implemented; (4) existing observer programs be examined and modified, including with respect to the placement of observers aboard vessels between 50 and 100 nautical miles offshore, to ensure that they provide statistically reliable information on the nature and magnitude of the interactions between Hawaiian monk seals and the commercial longline fisheries; and (5) the need for placing observers aboard vessels in the bottomfish and lobster fisheries be re-examined.

The Commission's comments on other specific aspects of the Hawaiian monk seal recovery program follow below.

## Specific Comments

Recovery Team: The Hawaiian Monk Seal Recovery Team meets annually to review the recovery program and to recommend to the Regional Director needed actions. To be fully effective, the Recovery Team should include persons who, as a group, provide the breadth of expertise necessary to address monk seal issues. Members should also have the time available to devote to the Team's work. With respect to the latter point, the Service should consult with the present Recovery Team Chairman, Robert L. Brownell, Jr., Ph.D., to be sure that he will be able to devote the necessary time to the Recovery Team's work given the demands that high seas driftnet and other issues will make upon him, particularly in 1992. With respect to membership, the U.S. Fish and Wildlife Service has not been represented on the Team since the departure of Robert J. Shallenberger, Ph.D., a point about

which the Commission wrote the Service on 9 October 1991. The Team also lacks members with expertise in behavioral sciences and physical oceanography.

To improve the effectiveness of the Recovery Team and to foster improved coordination among the necessary agencies in the Hawaiian Monk Seal Recovery Program, the Marine Mammal Commission recommends that the National Marine Fisheries Service: (1) either ensure that the present Chairman is able to devote an adequate amount of time to Recovery Team activities or appoint a new Chairman; (2) appoint Elizabeth N. Flint, Ph.D., U.S. Fish and Wildlife Service, to the Recovery Team; and (3) further augment Team membership with persons expert in the behavior of social mammals and physical oceanography. With respect to the chairmanship, the Commission suggests that the Service consider either William F. Perrin, Ph.D. of the National Marine Fisheries Service's Southwest Fisheries Center or Alec D. MacCall, Ph.D. of the National Marine Fisheries Service's Tiburon Laboratory to chair the Team should Dr. Brownell feel that he is not able to continue. In addition to including a behavioral scientist as discussed at greater length in this letter, the Commission also believes that a physical oceanographer should be added as well given the potential effects upon the habitat of small- and large-scale physical oceanographic changes.

Population Status and Trends: Much progress has been made in monitoring the population trends of the Hawaiian monk seal, but, as noted earlier, this often has been at the expense of other program elements. Dr. Ragen, the staff biometrician for the program, noted that analyses of the monk seal demographic data indicate that it is extremely difficult to detect changes in age-specific vital rates for each island group of seals. This is due to the limited sample sizes obtained from each group. As a result, the value of this information for detecting and assessing trends in these parameters within island groups is either limited or non-existent. In view of this finding and in recognition of the limits on support and program personnel, a basic question is whether it is either necessary or desirable to fully census each island group annually. It may be possible, for example, to cut population monitoring costs by concentrating annual census efforts on "key indicator" groups or groups of special concern (e.g., age-sex groups involved in the male mobbing problem). It may also be useful for the program staff to explore the use of alternative census schedules (e.g., alternate years) and/or alternative or complementary techniques (e.g., aerial photogrammetry).

The precarious status of individual island groups and the nature of factors, both known and not known, that affect each group independently, have led the Recovery Team to endorse annual censuses of each island group despite the demands this effort places on program funding and staff.

To possibly realize cost savings, the Service should examine and assess alternative and complementary or supplementary approaches to monitoring trends in abundance and productivity. To this end, the Marine Mammal Commission recommends that the National Marine Fisheries Service assess the costs and benefits of annual versus alternative and supplementary censusing regimes (e.g., alternate year censusing of key indicator groups, triennial censusing of key indicator groups, remote sensing, aerial photogrammetry to estimate annual productivity, etc.) for monitoring Hawaiian monk seals. The assessment should consider the benefits of reprogramming costs to other recovery program tasks more directly related to species restoration work and potential losses of data and information on individual island groups and the entire monk seal population.

Male Mobbing: The problem of female Hawaiian monk seals sustaining fatal injuries as a result of mobbing attacks by males is clearly a complex and pressing issue. The Hawaiian monk seal program staff and the Recovery Team believe male mobbing to be a significant source of monk seal mortality and an important factor in the decline of the population even though the quantitative evidence presently available may be somewhat equivocal and in need of documentation. The staff has proposed and the Recovery Team has endorsed a one-time experiment to reduce male aggression during the breeding season by chemically diminishing testosterone production and presumably libido. The results of this experiment would serve, together with other information, to provide guidance on the appropriateness of removing some specific number of adult males from the affected populations to eliminate mobbing as a source of female mortality. Although such treatment has reduced libido in males of other species, concerns for possible risks to individual monk seals and possible long-term consequences to the Hawaiian monk seal population as a whole have not been resolved and the results of experimental trials have not been made available to the Commission.

The Commission and its Committee of Scientific Advisors fully concur that female monk seals must be protected. However, although all members recognize that the issue must be addressed immediately, they are not certain as to the best and most appropriate approach. In large part, this is because of the less-than-complete levels of documentation of research on the nature and scale of the mobbing phenomenon, its significance to the population, and the possible short- and long-term effects of administering testosterone suppressant drugs to problem males. Such points were recommended by the Commission in its 4-5 December 1989 letter. Without these preparatory steps, reviewers find it difficult to reach any sound conclusions regarding either the proposed approach or alternative approaches, in terms of potential risks and benefits. Therefore, the Commission considers it essential that whatever approach is proposed be thoroughly reviewed and endorsed by the Hawaiian Monk Seal

Recovery Team after its members have been provided the necessary background information to allow for a careful assessment of risks to the population as well as any short-term benefits.

While the Recovery Team has addressed the mobbing problem before, it appears that it did not have the benefit of carefully prepared papers to consider in evaluating short- and long-term effects of the proposed action. If this is, in fact, the case, the Marine Mammal Commission recommends that the Hawaiian monk seal program staff, in consultation with pinniped behavior experts, develop for the Recovery Team and the Commission background papers on mobbing which include: (1) available information documenting the nature and frequency of male mobbing events; (2) the findings of studies as to which animals will be treated in the field and which animals will not be treated; (3) an assessment of the significance of these events with regard to the mortality rate of female monk seals and the decline of the Hawaiian monk seal population; (4) proposed mitigation actions including, but not limited to, the administration of drugs to suppress male hormone production; (5) an assessment of the possible beneficial and detrimental outcomes of each proposed mitigation action in terms of immediate and long-term effects on the population and the cost of each action; (6) a recommended course of action; (7) if it is decided that an experiment with testosterone suppressing drugs might materially contribute to solving the problem, an experimental design and decision criteria by which the results of actions taken will be evaluated; and (8) if a particular action is judged successful, a description of appropriate follow-up actions.

Consideration of approaches to addressing male mobbing would be enhanced by the inclusion of a behavioral scientist on the Recovery Team. In this regard, the Marine Mammal Commission recommends that the Service consider augmenting the Recovery Team by adding a behavioral scientist, such as Ms. Kathy Kreiger, Katherine Ralls, Ph.D., Randall S. Wells, Ph.D., Bernd Würsig, Ph.D., or some other person expert in designing experiments to assess and mitigate behavioral aberrations in social mammals. It may also be valuable for the Service to consider convening a 1 or 2 day meeting of behavioral experts just before the Recovery Team meeting with a view to obtaining recommended short- and long-term solutions. The Recovery Team needs such information when formulating its recommendations for dealing with the problem.

Location, Characteristics, and Habitat Use Patterns: As noted above, the Hawaiian monk seal's offshore demography, its foraging range and other habitat requirements, and its numerical and functional relationships with other components of the marine ecosystem are poorly understood. Noting the recent success of satellite tagging studies in obtaining such information on North Pacific fur seals, Steller sea lions, spotted seals, northern elephant seals, and harbor seals, reviewers concluded that

similar studies should be immediately organized for Hawaiian monk seals. Such studies could provide, among other things, information on: the use of habitat beyond the 50 nautical mile fishery protection zone around monk seal haul out areas; the extent of the habitat in which monk seals could reasonably be expected to be found and therefore potentially affected by adverse conditions; and the degree that Hawaiian monk seals and commercial fisheries (e.g., swordfish long-line fisheries, high-seas driftnet fisheries, etc.) use the same areas.

Therefore, the Marine Mammal Commission recommends that the National Marine Fisheries Service immediately develop and implement a satellite tagging program for Hawaiian monk seals to document, among other things, the species' seasonal distribution, its foraging range and preferred feeding areas, its feeding behaviors, and its interactions with commercial fisheries. In developing the program, the Service should take into account: (1) the components of an initial pilot program to be implemented this coming season; (2) the number of satellite tags (by age and sex class of seal) that would need to be deployed to yield statistically meaningful results; (3) the costs of the program in terms of equipment, field logistics, and data acquisition and analysis; (4) potential risks to individual Hawaiian monk seals from the tagging activities and the tags themselves; and (5) the value to the Hawaiian monk seal program staff of consultations with scientists now doing similar work with other pinnipeds.

Fisheries Interactions: Hawaiian monk seals are known to interact with the lobster fishery, the swordfish longline fishery, longline fisheries for other species, the bottomfish fishery for snapper and grouper, and the pelagic driftnet fishery for squid. The extent to which these interactions affect Hawaiian monk seals directly (e.g., entrapment and injury in gear or injury or death at the hands of fishermen protecting their gear and catch) or indirectly (e.g., depletion of monk seal prey or ingestion of or entanglement in plastic and other fishing debris) is not well understood. While praising the Service for its 18 October 1991 rule and earlier emergency rule implementing a protected species zone 50 nautical miles seaward of the Northwestern Hawaiian Islands (56 FR 15842, 18 April 1991 and 56 FR 52214, 18 October 1991), reviewers also noted that there are no data to support the assumption that Hawaiian monk seals do not interact significantly with commercial fishing vessels in waters beyond 50 nautical miles.

Furthermore, given that Northwest Pacific lobster stocks have declined to about 20 percent of their pre-exploitation size and that lobsters are known to be a preferred prey species for monk seals, there seems to be merit in trying: (1) to assess relationships between recent monk seal and lobster stock declines; and (2) to assess the potential benefits that restoring and maintaining lobster stocks at higher levels might have on

either hastening or facilitating the recovery of monk seals. To the best of the reviewers' knowledge, these issues have not been addressed. Therefore, the Marine Mammal Commission recommends that the National Marine Fisheries Service: (1) adopt Amendment 7 to the Fishery Management Plan for Crustacean Fisheries of the Western Pacific Region, including an indefinite extension of the emergency closure of the lobster fishery in the Northwestern Hawaiian Islands until such time as the lobster stocks return to optimal levels (see the Commission's letter of 6 December 1991); (2) initiate formal consultations with the Western Pacific Regional Fishery Management Council under section 7 of the Endangered Species Act to assess new information regarding the status of monk seal and lobster stocks; and (3) consider whether the Fishery Management Plan for Crustacean Fisheries in the Western Pacific Region adequately addresses ecological factors and possible second-order effects on Hawaiian monk seals.

Status and Plans for Tern Island: The Tern Island seawall must be repaired to stabilize the Island to ensure its availability as a research station, as the only wildlife protection enforcement presence in the Hawaiian Islands National Wildlife Refuge, and as a major haul-out site for monk seals. In addition, hazardous chemicals and debris left by former Navy and Coast Guard occupants must be removed. Although parts of each of these problems are being addressed by the Corps of Engineers, the Navy, the National Marine Fisheries Service, and the Fish and Wildlife Service, it became clear to all review participants, including the representatives of other agencies, that (1) there is a need to clarify agency responsibilities pursuant to the provisions of the Endangered Species and Marine Mammal Protection Acts and (2) interagency communication needs to be enhanced so that responsible agencies can cooperatively identify and address appropriate issues even more effectively than is now the case.

It was indeed gratifying to see agency representatives form a working group which met immediately following the formal program review; they also agreed to hold a follow-up series of coordination meetings to facilitate the taking of positive action and the resolution of any conflicts related to the stabilizing and cleaning up of Tern Island. In this regard, the Marine Mammal Commission recommends that the National Marine Fisheries Service, in consultation with other responsible Federal and State agencies, provide whatever support may be necessary for the formal working group to continue to meet regularly to: (1) identify, discuss, and resolve issues bearing on the restoration of Tern Island; and (2) to coordinate, facilitate, and hasten agreed restoration actions.

Status and Plans for Kure Atoll: Historically, Kure Atoll was a major breeding location for Hawaiian monk seals. Although its importance has been diminished dramatically over the past 30 years, reviewers felt that the reduction in human activity that

will occur at the Atoll after the Coast Guard leaves will enhance monk seal recovery and re-establish this location as one of great importance to monk seals. For this reason, reviewers were pleased to learn that the Coast Guard plans to close the Kure Atoll Loran Station by the end of 1992. They were concerned, however, about the need to make sure that the problems which resulted from the decommissioning of the Tern Island Loran Station (e.g., abandonment of debris which could entangle both monk seals and sea birds, and abandonment of potentially dangerous PCBs) not occur as a result of decommissioning the Kure facility. Reviewers also noted the need to make sure that decommissioning activities on the Island have the least disruptive effect possible on the seals.

Therefore, the Marine Mammal Commission recommends (1) that the National Marine Fisheries Service ensure that consultations with the Coast Guard on this matter under section 7 of the Endangered Species Act be completed in a timely manner, (2) that the resulting Biological Opinion thoroughly address both the removal of all hazardous materials and the need to minimize the impact of decommissioning activities to the greatest extent possible, and (3) that the Service place an observer on Kure to monitor disassembly and equipment removal activities to ensure that maximum protection is afforded the monk seals.

Captive Maintenance: Increasing numbers of monk seals have been taken and held in captivity for research and rehabilitation purposes. If the capture of adult males is used to mitigate the mobbing problems, this number will increase further. To help address identified captive maintenance problems in the past, the National Marine Fisheries Service established the Captive Monk Seal Review Committee. In this and other ways, the Service has moved to address the problems. However, because of uncertainties about the consistency of inspections by the Animal and Plant Health Inspection Service, the Marine Mammal Commission recommends that the National Marine Fisheries Service consider contracting with qualified marine mammal experts to visit facilities maintaining Hawaiian monk seals. This might be accomplished by asking scientists such as Joseph R. Geraci, V.M.D., Ph.D. or William Medway, Ph.D., D.V.M. to participate in formal inspections of the facilities in which Hawaiian monk seals are held and to provide such other reviews and advice as the Service may from time to time request.

Mediterranean Monk Seals: Reviewers were pleased to learn of cooperative efforts to share expertise gained in Hawaiian monk seal recovery efforts with those trying to protect the Mediterranean monk seal. Given the program staff's ability to offer practical, meaningful advice and assistance on saving what is a closely related species and the world's most endangered seal, the Marine Mammal Commission recommends that the Service continue its constructive contributions to Mediterranean monk

seal recovery efforts and provide such further advice and assistance as may be possible to scientists and managers working to encourage the recovery of the Mediterranean monk seal.

* * * * *

Much progress has been made in the monk seal research program since 1989. Among other gains, the Recovery Team has resumed its regular meeting schedule, significant additions have been made to program personnel, the budget has been increased to allow a broader range of important issues to be addressed, significantly greater effort has been placed on analyses and the publication of results, and the overview of monk seals in captivity has been greatly strengthened. The National Marine Fisheries Service is to be congratulated on this progress. With respect to actions which now need to be taken to more directly address recovery of the species, the Marine Mammal Commission looks forward to continuing to work with the National Marine Fisheries Service and other agencies. In this regard, it is the Commission's hope that this letter summarizing the November 1991 program review will be of value to the National Marine Fisheries Service, to the Recovery Team, and to other State and Federal agencies working to encourage the recovery of this endangered species.

Sincerely,

John R. Twiss, Jr.
Executive Director

Attachment

cc: Izadore Barrett, Ph.D.
George W. Boehlert, Ph.D.
Robert L. Brownell, Jr., Ph.D.
Rear Admiral Jack E. Buffington, USN
Rear Admiral William C. Donnell, USCG
Nancy Foster, Ph.D.
Mr. E. C. Fullerton
Mr. William G. Gilmartin
Colonel Leonard G. Hassell, Corps of Engineers
General Henry J. Hatch, Corps of Engineers
Admiral J. William Kime, USCG
Mr. Jerry F. Leinecke
The Honorable William W. Paty
The Honorable Jacqueline E. Schafer
Ms. Kitty M. Simonds
Mr. Robert P. Smith
The Honorable John F. Turner
Members of the Recovery Team

Draft Agenda
Hawaiian Monk Seal Program Review
National Marine Fisheries Service
Southwest Fisheries Center
8604 La Jolla Shores Drive
619/546-7081
La Jolla, California 92038
5 and 6 November 1991

5 November 1991

9:00-9:10 I. INTRODUCTION
Messrs. Boehlert and Twiss

9:10-9:40 II. RECOVERY PLAN/1991-93 WORK PLAN AND RECOVERY TEAM
Mr. Gilmartin

A. Recovery Plan/Work Plan funding for 1991 & 1992
B. Schedule for updating Recovery Plan/Work Plan
C. Recovery Team (Membership Changes & Meeting Schedule)

9:40-11:00 III. RESEARCH ACTIVITIES AND PRIORITIES
Dr. Ragen

A. Population Status and Trends

1. Objectives, methodology, and execution of population monitoring work
2. Population trends by age/sex/atoll and results of recent beach counts and status of population analyses
3. Possible causes of declines in pups and other age classes
4. Adequacy of methodology
5. Future population monitoring work, plans, and funding needs

11:00-12:00 B. The Male Mobbing Problem
Mr. Gilmartin

1. Nature, location, and extent of the problem
2. Status of studies initiated to date
3. Results of field studies and work on captive seals
4. Research activities, plans, and funding needs for 1992 and beyond

12:00-1:30 Lunch

1:30-2:30 Mr. Gilmartin — C. Location, characteristics, and habitat use patterns in critical habitats and other essential habitats

1. Objectives, methodologies, and results of field work to date (e.g., radio-tracking, depth-of-dive studies, assessments of prey preferences and food resources, etc.)
2. Research activities, plans, and funding needs for 1992 and beyond (including depth of dive work and radio tracking to determine use of areas beyond 50 miles from islands)

2:30-3:00 Mr. Gilmartin — D. Other Research Activities

1. Status of and plans for work to test genetic differences
2. Status of and plans for studies of immature growth rates
3. Status of and plans for studying antibodies to various diseases
4. Status of and plans for field work on foraging efficiency

3:00-3:30 Mr. Gilmartin — E. Mediterranean Monk Seal

1. Status of research related to morbillivirus
2. Views regarding field inoculations
3. Future role for U.S. participation in Mediterranean monk seal recovery efforts

3:30-4:30 Mr. Gilmartin — F. Research Summary

1. Status of data analyses and publication of research results
2. Staffing
3. Priority work scheduled for 1992
4. Funding needs for priority work
5. Permit needs (if any) and status of preparation for work in 1992
6. Comparison of projected activities with priorities and funding in work plan
7. Priority work not addressed in 1992 funding plans

4:30-5:00 Messrs. Boehlert and Gilmartin — IV. Program Administration and Oversight

A. Activities of Animal Care Committee
B. Recovery Team Advice and Recommendations
C. Staffing (including new hires, and remaining needs)

6 November 1991

V. MANAGEMENT ACTIVITIES AND PRIORITIES

9:00-10:0 A. Fishery Interactions
Messrs. Lecky and McDermond

1. Summary of evidence (documented injuries & reports) for interactions in bottomfish and long-line fisheries
2. Status of regulations for bottomfish and pelagic long-line fisheries
3. Status & plans for observers on bottomfish and pelagic long-line vessels within and beyond 50 mile radius
4. Status of other fishery management plan provisions (including requirements for orientation meetings, carrying satellite transmitters, and reporting)
5. Status of enforcement activities and Coast Guard overflights

10:00-11:00 B. Status of Plans for Tern Island
Messrs. McDermond, Young, Gilmartin, and Gerheiser
Ms. Stahl

1. Status and work schedule for engineering studies and remedial work on:
   a. Fuel removal and tank stabilization
   b. Sea wall repair
   c. Other (i.e., removal of Coast Guard generators and debris on other islands)
2. Status and source of $50 K contribution from FWS and NMFS to the Navy
3. Consultation schedule and arrangements between FWS/NMFS/COE/Navy biologists, engineers, and resource managers
4. Permitting and environmental report documentation (including cooperative arrangements between Navy/COE/FWS/NMFS to meet needs in a timely manner)

11:00-11:30 C. Coast Guard Activities at Kure Atoll
Lcdr. Valerio

1. Status and implementation of restrictions on Coast Guard personnel use of beaches
2. Status and scope of section 7 consultations with Coast Guard on closing the Kure station
3. Results of May Coast Guard/State/NMFS "walk through" at Kure
4. Update on state plans for Kure Atoll
5. Status of long-term arrangements (including permit requirements) with the State to continue

monk seal research and management work and use Atoll facilities

11:30-12:00 D. Navy Activities at Midway Island

1. Status of Navy plans regarding level of use of Island
2. Plans for section 7 consultation regarding changes in Navy plans and use

12:00-12:30 E. Kure Atoll Head Start Program and Pup Rescue, Rehabilitation, and Release Program
Mr. Gilmartin

1. Objectives and methodology for head start and rehabilitation programs
2. Results of work to date
3. Plans for 1992 and beyond (including plans to expand work to areas other than Kure)

12:30-2:00 Lunch

2:00-2:30 F. Captive Maintenance
Mr. Gilmartin

1. Number, location, and status of captive monk seals
2. APHIS inspections
3. Status of staff training in care and maintenance
4. Implementation of protocols for water quality, food quality, nutrition, disease prevention, veterinary care, record keeping, and necropsies

2:30-3:00 G. Debris Clean-up and Seal Entanglement
Messrs. McDermond and Gilmartin

1. Objectives, methodology, and results of clean-up work to date
2. Trends in occurrence of debris (including light sticks and entangling debris)
3. Trends in occurrence of seal entanglement
4. Status of efforts to prevent disposal of light sticks and other debris (including efforts to advise fishermen of legal requirements regarding their disposal)

3:00-3:45 IV. Management Summary
Messrs. Boehlert and Gilmartin

1. Summary of formal (section 7) and informal consultation needs with State, FWS, COE, WPRFMC, Navy, and Coast Guard and timing of consultations

2. Present allocation of resources (dollars and people) within the program

3. Summary of funding needs and sources (e.g., for fishery observers and contribution to Tern Island work)

* * *

Marine Mammal Commission personnel, who do not live in the La Jolla area, will be staying at the:

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# APPENDIX D

# HAWAIIAN MONK SEAL
# REPORTS AND PUBLICATIONS OF PROGRAM AND COLLABORATING SCIENTISTS (1981-1993)

**PROTECTED SPECIES INVESTIGATION MARINE MAMMAL RESEARCH PROGRAM**
**Southwest Fisheries Science Center Honolulu Laboratory**
**National Marine Fisheries Service, NOAA**
**Honolulu, Hawaii 96822-2396**

## Journal Publications

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